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SCIENTIFIC AMERICAN

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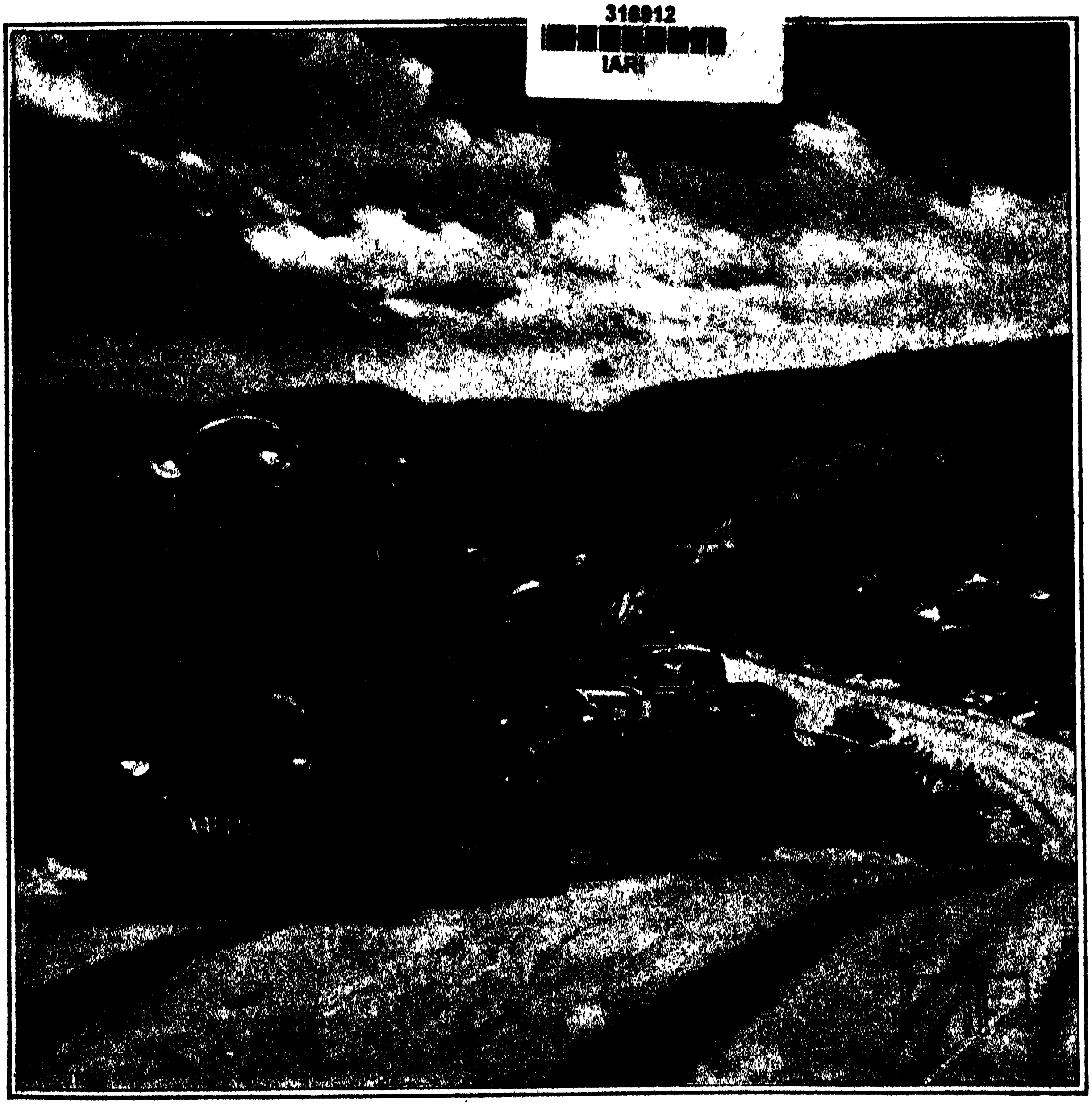

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By DR. ALBERT SHAW

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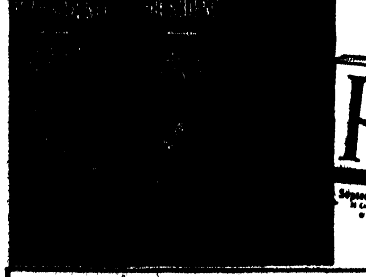

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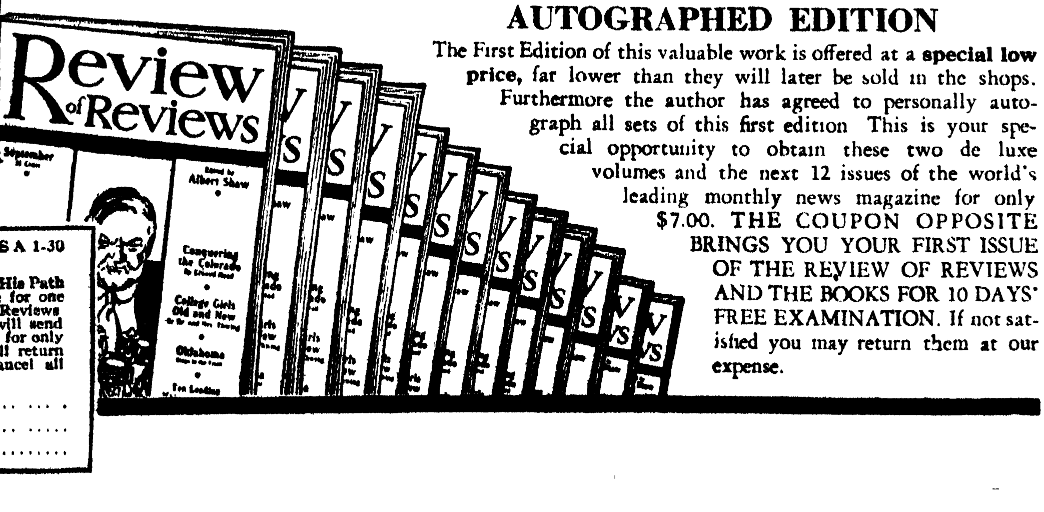

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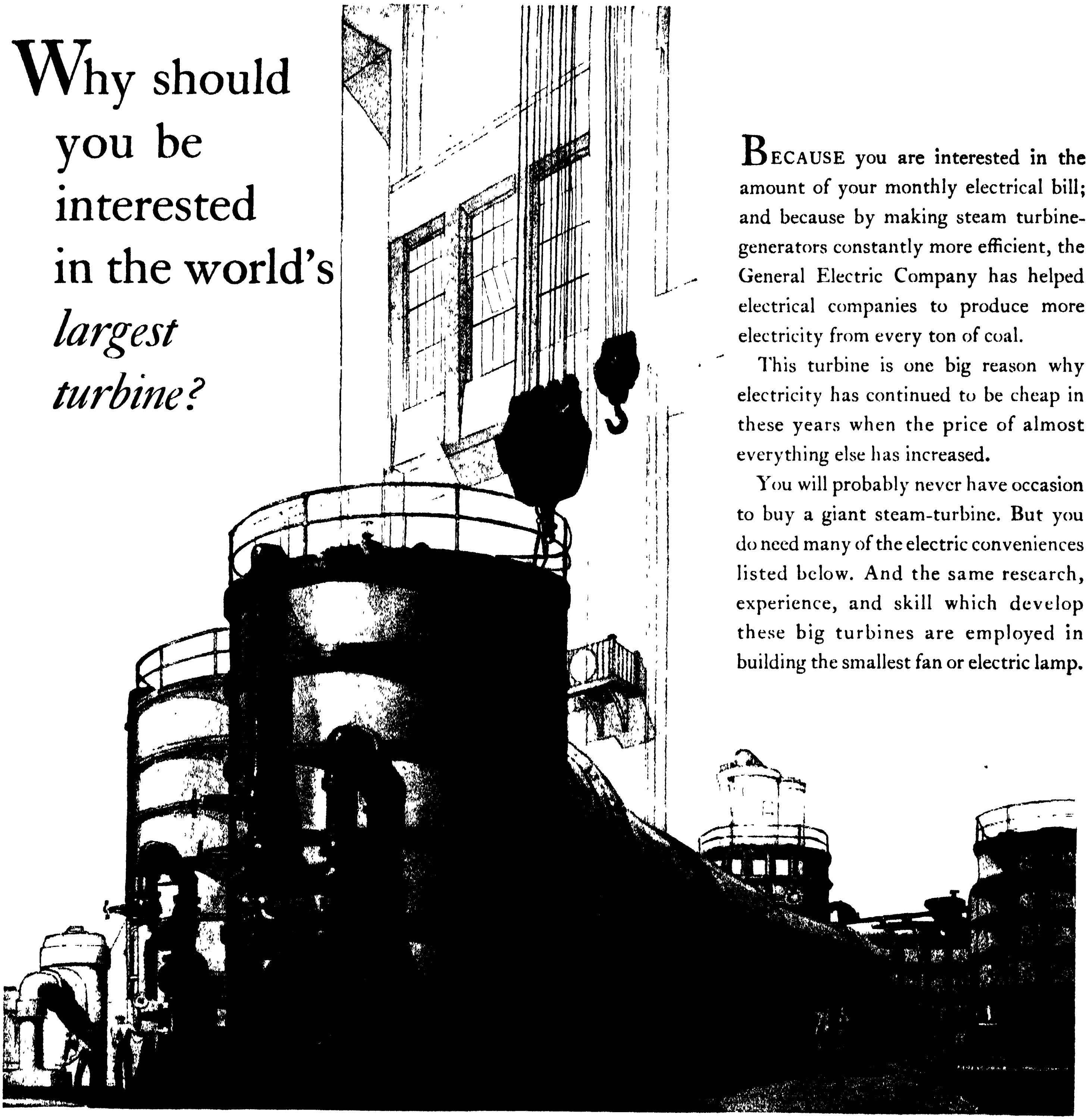

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January 1930 *Edited by ORSON D. MUNN* *Eighty-sixth Year*

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COVER

When cars are driven under their own power from assembly plant to dealer, the motor is occasionally abused before it reaches the buyer. Our cover, painted by Howard V. Brown from information supplied by the Nucar Forwarding Corporation of Trenton, New Jersey, depicts a special truck and trailer arrangement which permits shipment in one unit of from four to six new cars directly from the assembly plant to the dealer, without even starting the new motors.

The Universe Around Us

By Sir James Jeans,
Cambridge University

WRITTEN in a style the average man can understand, Sir James, while recognized as one of the most famous and ablest cosmological thinkers, is able to enhance his subject and fascinate the reader by his presentation. Other scientists readily concede his ability in this line as well as his standing in science. This work will stir profound thought in the reader who likes to think; its scope is as broad as the universe, extending from microcosm to macrocosm.

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By C. D. Hodgman and N. A. Lange
Case School of Applied Science

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By A. A. Knowleton, Ph. D.

WE all have occasion to look up questions in physics and it is usually the case that we want a reference which will explain in understandable terms without intricate details or extended mathematical formulae. Just such treatment will be found in this text, which is unusually clear, concise and conclusive. A valuable work for the reference library.

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A History of Mechanical Invention

By A. P. Usher
Asso. Prof. Economics, Harvard

IT is a curious fact that this branch of the Arts has fewer histories or records of accomplishment than any other. Yet it is a fact that this is one of only three works of importance—one at least of which has been out of print for many years. Realizing this fact the author ably supplements the others.

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Looking Ahead *With the* Editor

Needed: A Bigger Merchant Marine

IN an article soon to be published, E. M. Herr, Vice-chairman of the Board, Westinghouse Elec. and Mfg. Co., discusses the vital relationship between ships and American prosperity. He says that we have been "slipping back into our old position of almost complete dependence on foreign ships for handling our sea-borne commerce," and urges development of wider markets, the building of more ships to handle our commerce, and public support of a bigger merchant marine.

How Old Is the Earth?

BY measuring the rate of decay of radium contained in Yellowstone Park geysers, scientists have estimated the time that has elapsed since ice extended down to these geysers during the Great Ice Age. In a like manner, uranium, which has a much slower rate of disintegration, may be used to estimate the age of the earth's crust wherever it is present. You may read of this interesting and valuable research in an early issue.

Another "Lost City of Nevada"

SCIENTISTS feel confident that many secrets of ancient Pueblo Indians lie buried in the earth of southeastern Nevada. At Mesa House, relics and artifacts tell a mute and colorful yet pathetic story of how these peace-loving Indians lived, worked, progressed, held their own against warlike tribes by building on plateaux, and finally surrendered to superior strength. Look for the coming story on Mesa House.

Vastly Improved

THE Chicago Civic Opera House and Civic Playhouse, recently completed, is said to have the finest mechanical stage equipment of any house of its kind in the world. A forthcoming article will describe its entirely new lighting system which is so arranged that the lighting director can view lighting effects from a concealed position, its hydraulically operated traps and bridges, and, in fact, all its excellent features.

Running Horses

WHO really invented the "movies?" Few people, even among those who have a hazy notion that running horses had something to do with the invention, would connect the name of Leland Stanford with the early experiments. An article ready for release tells of the first "flippack" photograph "movies" made on Stanford's stock farm, the many interesting details of problems encountered, and the later developments.

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¶ Read this magazine carefully. If you like it, you will like succeeding issues also. Better make sure of getting it regularly every month. A subscription, costing only four dollars, brings 12 issues to you.

Among Our Contributors

C. F. Kettering

FEW men today can show a record of achievement in industrial research comparable to that of Mr. Kettering. Born on a farm in Ohio, he was graduated from Ohio State University in 1904, and received a degree of Doctor of Science from the University of Michigan in 1928. Going to Dayton years ago, he organized the Dayton Engineering Laboratories to manufacture Delco starting, lighting, and ignition systems which he invented. A vice-president of General Motors Corporation, he is also an executive in other large companies, and is a member of a number of engineering associations and societies.

William F. Sturm

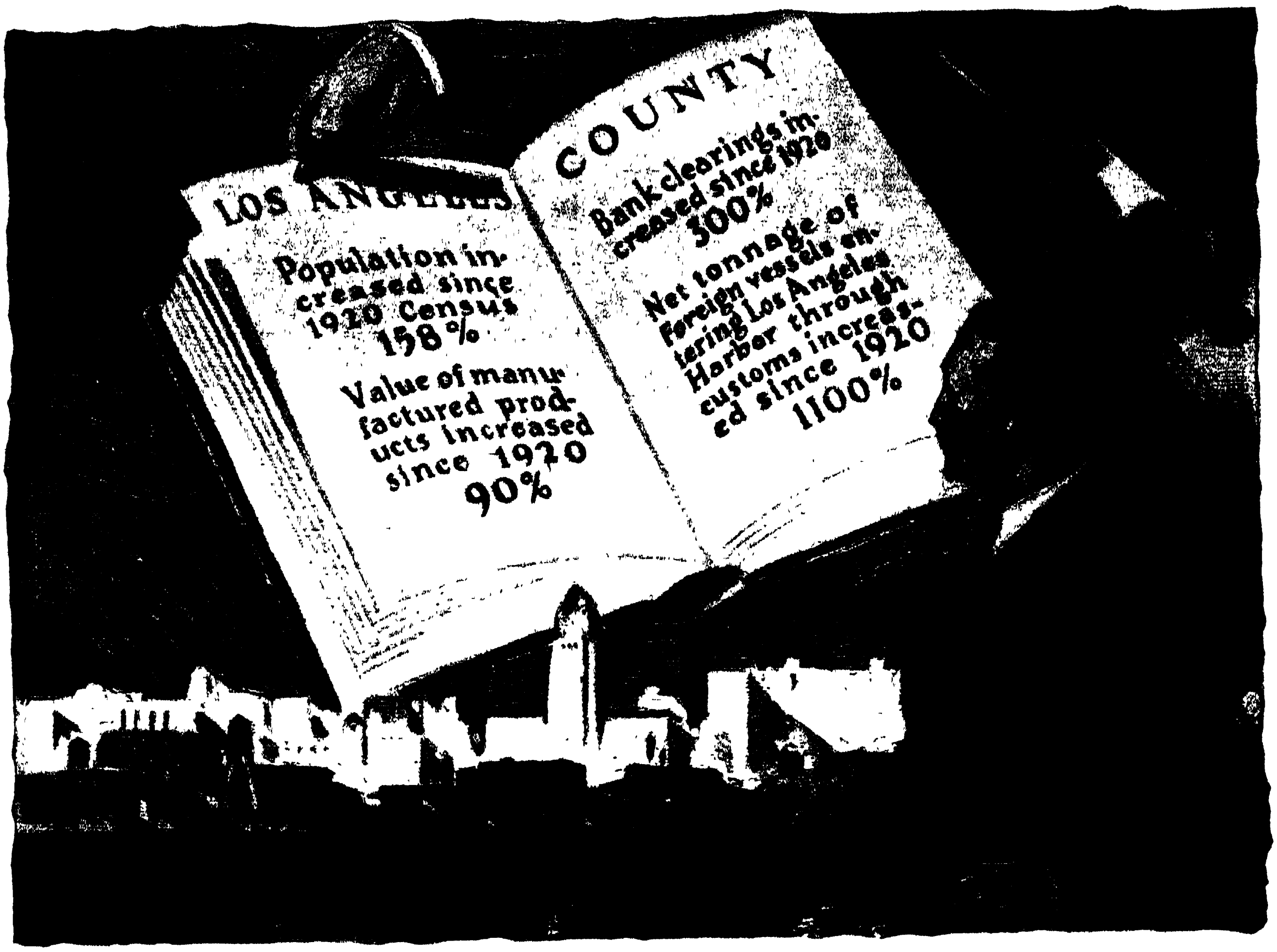
CONVERSANT with the policies and aims of the Indianapolis Speedway since its construction in 1909, Mr. Sturm was a member of the Contest Board up to a year ago. As a writer on racing matters, he has long since won his spurs, having contributed articles to such magazines as *The Saturday Evening Post, Liberty,* and others.

Roswell H. Ward

MR. WARD is one of the pioneer advocates of the aviation Diesel engine. For some time he was associated with the former Army Air Service research establishment at McCook Field and with the Curtiss-Wright interests, and has been a prolific and far-seeing journalistic interpreter of the Diesel in its land, sea, and air applications.

Aristid V. Grosse

WE who live on the peaceful side of the globe may find it exceedingly difficult to believe that any serious scientific research could be pursued in war-torn China, yet the article by Dr. Grosse on page 42 indicates that such is an actuality. China is an immense country in which a war or two is easily lost; and Chinese institutions "carry on" in spite of them. Taking occidental scientific thought as its background, the orient is laying the foundations of a future age of science of its own, and—who knows—it may be more brilliant than ours!


LOS ANGELES
COUNTY
Population increased since 1920 Census 158%
Value of manufactured products increased since 1920 90%
Bank clearings increased since 1920 300%
Net tonnage of foreign vessels entering Los Angeles Harbor through customs increased since 1920 1100%

A RECORD OF DEVELOPMENT UNSURPASSED IN HISTORY

JUST so long as Southern California continues to enjoy its delightful year 'round equable climate, and other living advantages; and just so long as human nature remains as it always has been . . . people will continue to flock to Los Angeles County.

It is but necessary to study indices of the past to see that this area must inevitably become one of the greatest consumer markets of the world. Today, it is by far the largest *concentrated* market on the Pacific Coast. And it is substantially increasing its lead every year.

Industrialists who are entrusted with the destinies of great manufacturing plants and who must consider the economics of production, distribution and markets, are bound to realize the importance and the good business of locating plants in Los Angeles County to serve this great metropolitan area . . . . and the whole Pacific Coast . . . . and to develop the tremendous virgin export markets of the Far East.

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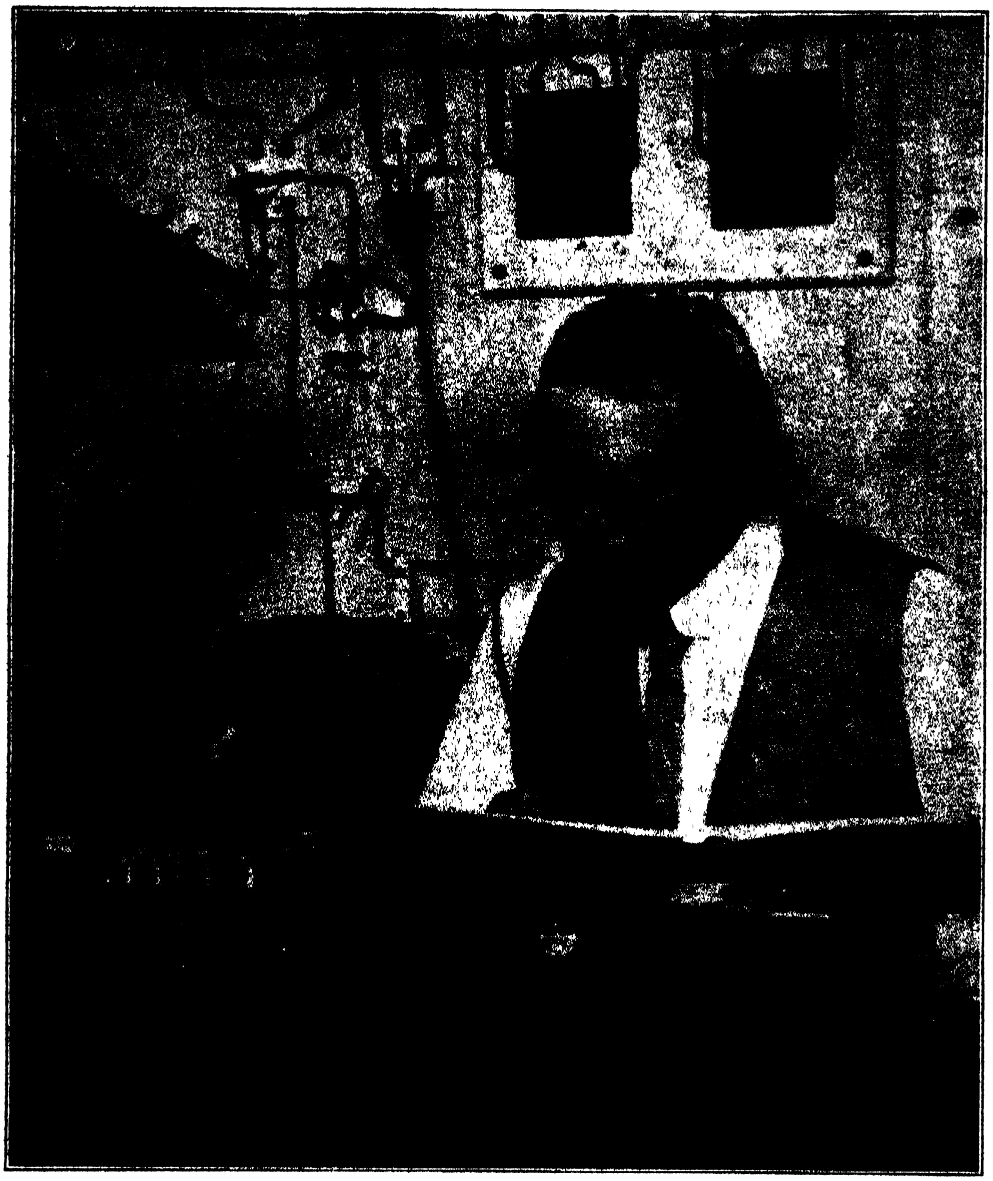
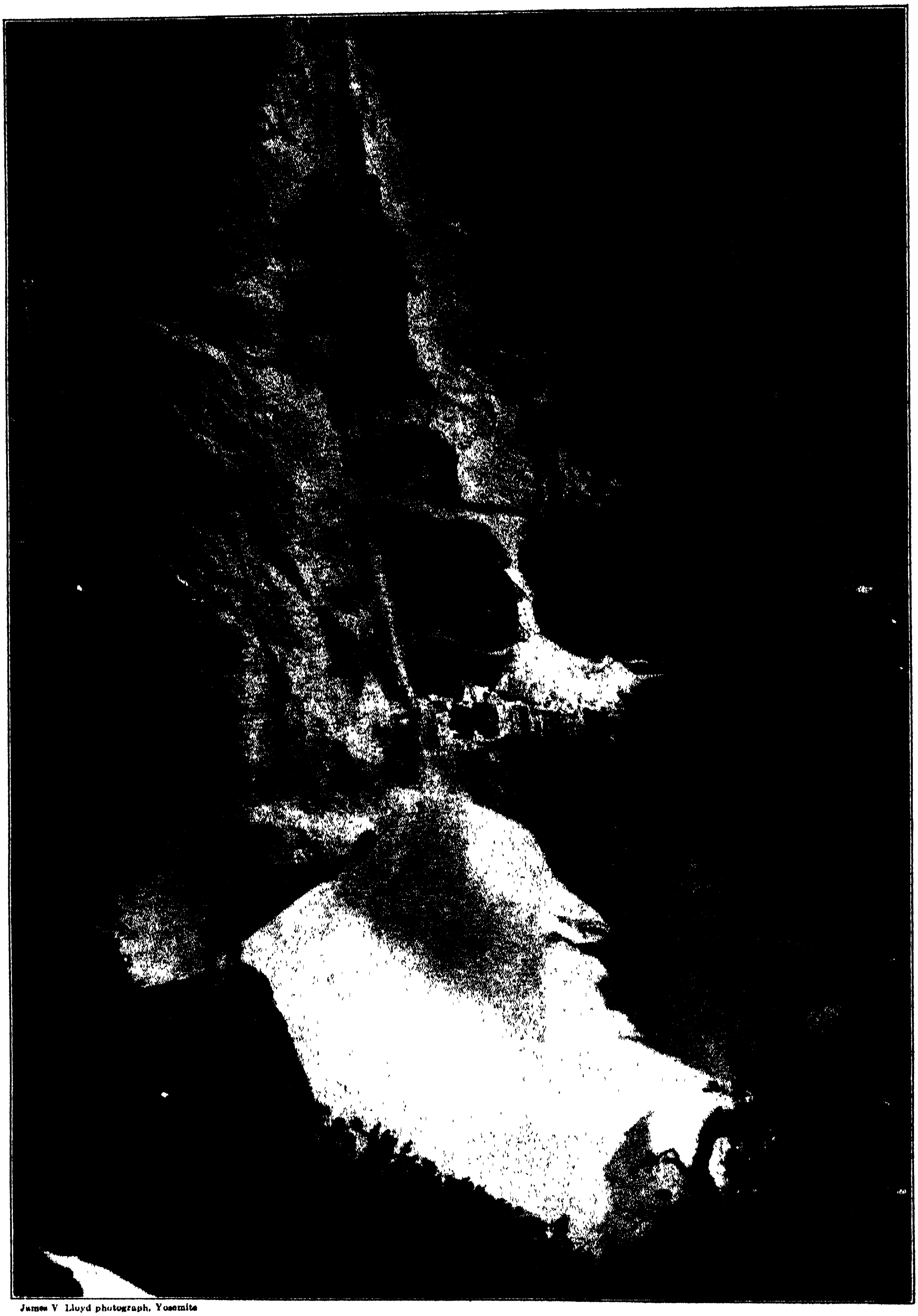


Reginald A. Fessenden

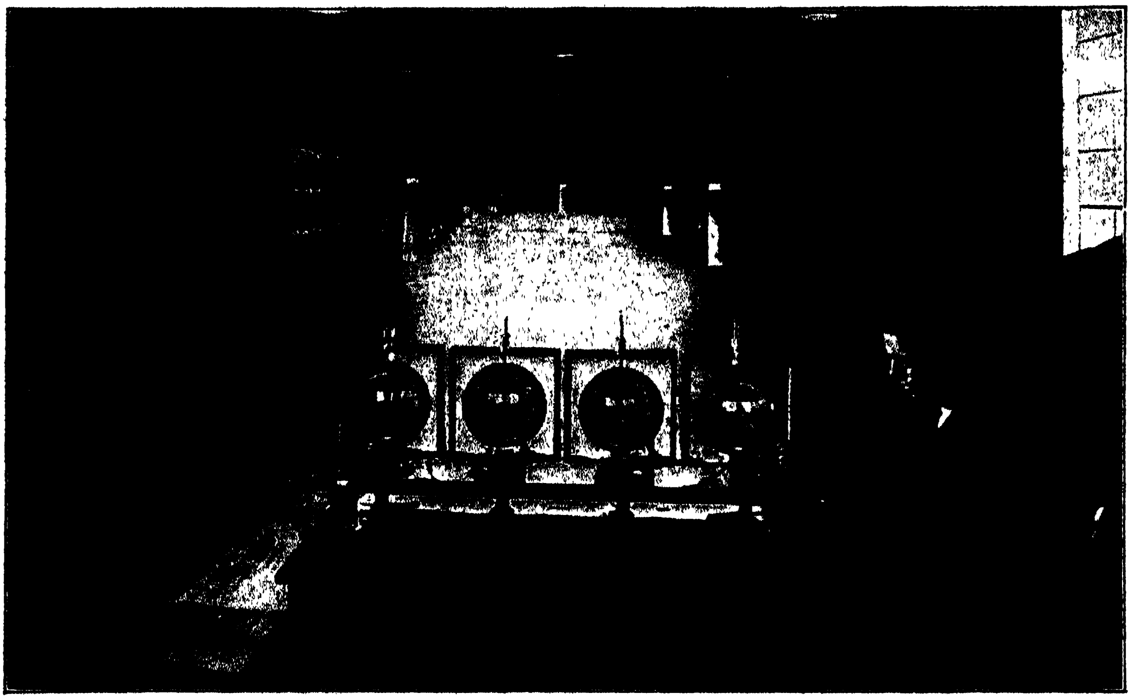
PROFESSOR REGINALD A. FESSENDEN has been awarded the SCIENTIFIC AMERICAN Medal for Safety at Sea by the American Museum of Safety, who appointed an extremely technical committee composed largely of naval officers, captains of vessels, and naval architects. Eighty competitors from 13 countries strove to win the famous gold medal which is so rarely bestowed. Professor Fessenden's achievement in devices for protection to life at sea won overwhelming recognition. Born in the Province of Quebec on Oct. 6, 1866, Professor Fessenden was employed at the Edison machine works in 1886 and 1887 and for three years thereafter was head chemist of the Edison laboratory. Later he was Professor of Electrical Engineering at Purdue University and Western University of Pennsylvania. He was special agent of the Weather Bureau from 1900 to 1902 and general manager of the National Electric Signaling Company from 1902 to 1910. Since then he has been consulting engineer of the Submarine Signal Corporation of Boston. Owing to illness, Professor Fessenden was unable to receive the medal personally at the Union League Club on November 7th, so his son officiated in his stead. Everyone will wish Professor Fessenden a speedy recovery and long life.



James V Lloyd photograph, Yosemite

Yosemite's Winter Finery

THE cold of winter evenings turns the spray of Upper Yosemite Falls, which has a drop of 1430 feet, into ice that coats the entire cliff face. When the sun strikes this section of the canyon walls, the ice melts off in chunks that accumulate at the base of the falls. The ice piles up during the winter so that sometimes by March 15, the ice talus cone is 250 feet high.



"HOW FAR THAT LITTLE CANDLE THROWS ITS BEAMS"

Unlike Portia's candle, automobile lights must be controlled. Here we have the interior of a headlight testing room where reflector types are tested for glare, strength and direction of beam, height above ground, et cetera. An actual car, in laboratory background, is used here

Research Made Your Motor Car

The Car of Today Is a Vast Improvement Over That of 1920. Constant Research and Development Made It Possible

By C. F. KETTERING*

Vice-President of General Motors Corporation, and General Director of the Research Laboratories

SUPPOSE that ten years ago a brand new automobile, 1920 model, had been sealed up in a glass case. Suppose also that the seal was such a good one that nothing at all has happened to the car with time, but that it is in perfect condition today—not a speck of rust; not a bit of tarnish. The price of the car was 1500 dollars in 1920. What would you give for it now?

Before you decide, look the car over pretty carefully. You will see that it does not have four-wheel brakes, nor balloon tires, nor Duco finish. It is painted all in black, with no relieving color, except for some stripes of yellow. It has no air cleaner, no oil filter, no ventilator in the crankcase, no fuel pump, and no shock absorbers. You should know also that, although the engine is almost the same size as that in the present model of the equivalent make, its power is much lower; the car will not pull hills as well nor run as fast. But then you would not want to drive it so fast anyway, for it does not steer as easily, the engine does not run as smoothly, and the whole car does not ride nearly as comfortably as the up-to-date model does.

Now that you know all this, what do you bid for the car? It is safe to say that you would not pay over 500 dollars for it. But why not? This is not a "used" car. It is just as good as it was the day it was made. This car sold readily for 1500 dollars in 1920. Why is it worth only one third as much to you today?

THE answer is that that differential of 1000 dollars is the figure at which you, as a representative customer, reckon the value of the research and the engineering work of the past few years. The difference is not that the early car is any worse today than it was in 1920, but that the present car is so far superior to it that people think it is a thousand dollars better. And in that judgment they are not mistaken.

The National Research Council recently sent a questionnaire to a large number of American manufacturers, asking about their activities in research. An analysis of nearly 600 of the replies received showed that 52 percent of the manufacturers do some industrial research. Now it is certain that, if such a census were taken within the automobile industry alone, the percentage would be much higher. The motor car industry is unique in that *every* manufacturer who expects to stay in the business must be constantly experimenting and improving his product. And therein lies one of the outstanding reasons why the automobile industry has gone forward by leaps and bounds. It is certainly true that so far as the motor car business is concerned there are no park benches for it to rest on. There is only one place where park benches may be found, and that is immediately in front of the undertaker's office.

The opinion is sometimes heard that the yearly bringing out of new and improved models of cars is a bad thing for the public, and therefore for the industry. This opinion was expressed to me not long since by a man who had just been into an automobile sales-room to look at a new model of the car he had been driving.

"I was tremendously impressed with the new car," he said. "It was beautiful. The advance made was quite marvelous. The only thing that made me sore was that they would not allow me within 200 dollars of what I expected on my old car. The thing that you did in bringing out that new model was to depreciate 200 dollars worth every one of the cars you made last year."

---

*See "Among Our Contributors," page 5.

"You are wrong in that," I replied. "Did we put so much as a scratch on the paint of your present car? Did we harm a bearing or score a cylinder? Did we break a spark plug? Did we punch a hole in your gasoline tank between last night and this morning?"

"No, I'll admit that you didn't do any of those things," he answered.

"But you say we depreciated your car to the extent of 200 dollars between yesterday and today," I continued. "No, we did not *de*-preciate your car. What we did was to *ap*-preciate to the extent of 200 dollars' worth your idea of what a car ought to be. All we did was to show you an automobile so far superior to your old one in several particulars that, despite the fact that you are complaining about the allowance on your old car—which, after all, is merely what someone else is willing to pay for it—you are going to buy the new car anyway, aren't you?"

"Sure," he replied.

"THEN you have learned that it is worth 200 dollars to have a change of mind," I said. "If we had not elevated your mental idea of what an automobile should be, you would not have bought a new car, would you?"

"No."

"Then, we would not make the new car, the steel mill would not produce the steel, the paint factory would not make the paint, the textile mill would not weave the cloth, the tire factory would not manufacture the tires, the glass mill would not make the glass, the railroad would not haul the freight—and then business would not be so good."

The relationship of industrial research to the automobile is a very intimate one, for it is only as a result of an immense amount of research and experimentation that we have the automobile at all. The motor car is said to have been made possible by three things: rubber, alloy steels, and petroleum. That is the truth, perhaps; but it is not the whole truth, for the scientific and practical developments that have made the up-to-date automobile possible came from a great many sources. Electric lights, for instance, are certainly very essential to the utility of the motor car, even though they do glare at us too much sometimes. But without the single development of ductile tungsten it would not have been possible for us to put electric lights on automobiles.

DANGER—100,000 VOLTS

A wire cage grounded on pipes is used in automobile research laboratories to shield experiments from electrical disturbances

We all take electric lights on cars and everywhere else as a matter of course. So some of us may have forgotten that the long research conducted by Dr. W. D. Coolidge and his helpers, which resulted finally in the discovery of how to make ductile tungsten wire, was one of the great classics of scientific as well as of practical research. And probably none of us has computed, nor can compute, how much we owe to that one development. Ductile tungsten has meant much to the motor car, because carbon filament lamps were too inefficient to be practical for automobile headlights, and the early tungsten filaments were so fragile that on a moving vehicle they would quickly have shaken to pieces.

IT was the search for smokeless powder that constituted the first of the long series of hard-won battles which have made possible the durable and attractive lacquer finishes on cars today. The grandfather of Duco was gun-cotton. One of the principal problems that had to be solved in connection with the use of lacquer finishes on automobiles was that of securing suitable solvents for nitrocellulose, and of providing them cheaply enough and in adequate amounts. This problem was finally solved by the combined efforts of the bacteriologist, the synthetic chemist, and the chemical engineer; but it was not solved without a great deal of patient research.

Many of the essential contributions to the motor car have come out of research and development in other industries apparently remote from it, such as in ceramics, storage batteries, abrasives, synthetic resins, celluloid, glue, pulp products, leather and coated textiles, electro-chemistry, and even such an apparently unrelated thing as the setting of diamonds. The automobile draws upon almost every industry in the country, and upon some of them in a large way. Immense amounts of glass, leather, rubber, lumber, steel, aluminum, copper, tin, lead, zinc, nickel, chromium, cotton, wool, glue, paint, varnish, and goodness knows what are used in making motor cars. The motor car, being the ultimate consumer of many types of manufactured goods, naturally benefits from the research done in the industries that supply it.

If it had not been for just one of the developments in alloy steels, namely, high-speed cutting tools, it would scarcely be possible to make automobiles, or at least it would not be possible to make them as cheaply and as accurately as is done today.

WITH the aid of these tools, the more than 10,000 parts that every automobile consists of can be shaped with the greatest rapidity, and at the same time with the utmost precision. So hardy are these teeth of steel that they tear away on one piece of metal after another at such a terrific rate that they get very hot at the task. But that does not make them one whit the less effective. The finished pieces they turn out so speedily are always "interchangeable." They are every one exactly alike; and, with the exception of just a few pieces, the man who assembles them into the final product need make no selection whatever. Generally he can use one of the pieces just as well as another. And even in the case of those few parts where, in order to get a perfect fit, a selection is sometimes made, the choice lies between parts that differ in size by the fraction of a hair's breadth only.

Anyone who has ever had to "run in on the rim" has a pretty good idea of how large has been the contribution of rubber to the automobile. The slow and bumpy progress that he had to make then was just a little taste of what the automobile would be like without the pneumatic tire, or of what it would be like if he had to run *all* the time on *four* unyielding rims. By making it possible to glide smoothly along on a cushion of air, the rubber tire has done more to make the motor car a satisfactory and useful vehicle than people usually give it credit for. But the rubber tire is altogether a product of research, of research which has been long and persistently pursued, and which is still being carried on intensively.

Likewise, it is only as a result of much research and experimentation in the petroleum industry that the constantly mounting numbers of automobiles have been kept on the roads. Research in the geological location of oil deposits has enabled more and more petroleum to be found. But this alone would not have been enough. If the oil refiner had not found out how to make more gasoline out of the petroleum that passed through his refinery than he made 20 years ago, it would have taken nearly four times as much crude oil as it did to yield the gasoline consumed during the past year. It is true that there is plenty of petroleum today. But where would we get four times as much as we consume now?

THE large improvement in yield of gasoline, and the consequent lesser consumption of petroleum per car, came about as the result of an immense amount of research and experimentation, first, on making gasoline by "cracking" heavier oils; second, on extracting gasoline from natural gas and from the gases produced in refineries; and, third, on improving the means of separating from petroleum the gasoline present in it as it is removed from the oil pool. The result of all this research has been that during the past 20 years the amount of gasoline produced from each barrel of petroleum pumped into the refinery has gone up from 4.5 gallons to more than 17 gallons.

DOES IT WEATHER?

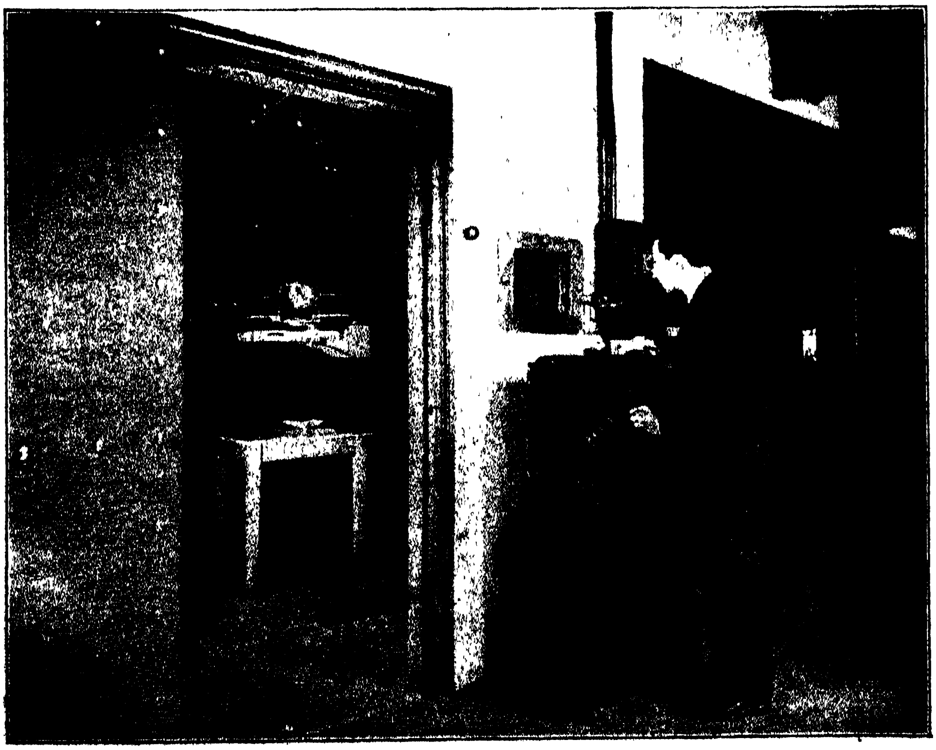
A series of lacquered plates passes through water and then under a powerful light to test lacquer weathering

In the engineering features of automobiles there has been, of course, an immense amount of persistent experimentation from the very outset. In the matter of engines, for example, constant experiments have been made on the best ways to construct them, on how to lubricate them and to cool them, on improving the balance of engines and the smoothness with which they run, on valves and means of opening and closing them, on shapes of combustion chambers, on means of getting ignition and of controlling it, on carburetion and atomization of the fuel, and on means of equalizing the distribution of charge to the various cylinders.

Much experimentation has also been carried out on such features as transmissions, differentials, axles, brakes, steering gears, and closed bodies. As a result of this constant research and experimentation, the gradual evolution of the automobile has all been toward more useful, more beautiful, and more economical cars, as well as cheaper ones.

The researches that have resulted in putting a motor car into nearly every American family have not all been confined to the fields of science and engineering. Research, whether it be strictly scientific or both scientific and practical—and it is scarcely ever one without the other—consists simply in getting the facts. In order to make automobiles cheaper and cheaper as well as better and better, it has been necessary to get the facts on materials, engineering, purchasing, manufacturing, sales, service, advertising, and many other things.

And so the motor car is quite definitely a product of research. It represents a result of the application of scientific and practical discoveries to everyday life. The huge automobile industry has arisen largely through commercial research having acted as a translator of scientific ideas to a traveling public.



IS IT UP TO THE STANDARD?

At intervals, castings of various parts that are to go into automobiles are examined by means of the X ray. The X-ray room is shielded to protect the operator from dangerous rays

SCIENCE in general needs an interpreter to translate its discoveries into products that are useful to ordinary people, and that is one of the principal functions of industrial research. The general purpose of research in industry is to discover, analyze, and recommend improvements in products and methods, and in the automobile industry there is an immense amount of this kind of experimentation going on. Such experimentation is not what is called fundamental research, but it is research, nevertheless, and a very useful form of research as well.

The results of research that have gone into the automobile have meant much to the ordinary man. The first way in which it has benefited him is in his ability to buy a valuable means of getting about the world, which, if it had not been for the large amount of research and experimentation put into it, he could not possibly have. Twenty-five years ago the man who had an

FOR STRUCTURALLY PERFECT METAL

It is necessary to know the crystalline structure of metals used in the production of finished parts. Here a metallurgist is examining a piece of metal with a powerful photo-microscope

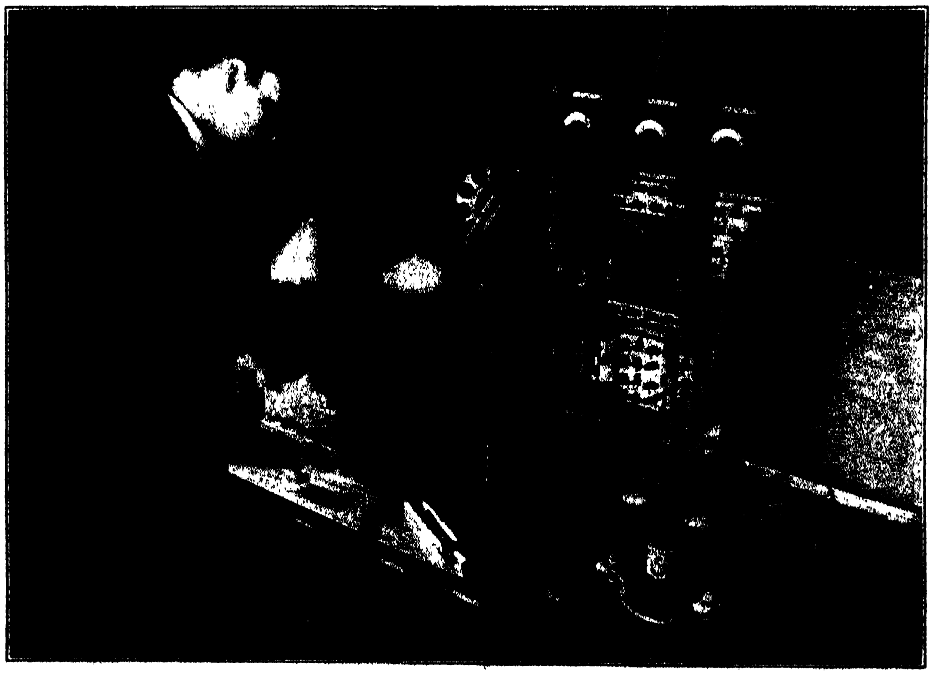
automobile was on a par, from the viewpoint of transportation, with the man who had a chariot 2500 years ago. Now nearly every family has a car, even the worst of which is so far ahead of the ancient chariot—or of the early automobile, for that matter—that the carriage of the ordinary working man is one the like of which the ancient king never even dreamed of having. That the ordinary man today has a multitude of things the ancient king could not command with all his wealth has come about altogether as a result of that persistent experimentation, which of recent years has been organized and called industrial research.

THE second way in which the continual research on the motor car has benefited the ordinary man is in the relatively lower price he has to pay for his automobile than for most other things he buys. Although the cost-of-living dollar is now worth but 62 cents as compared with 1914, the automobile-purchasing dollar on the same basis is worth $1.13. So, as a result of much persistent experimentation and consequent development within the automobile industry, a dollar will go nearly twice as far in the automobile salesroom today as it will on the average in other places where goods are sold. If the cost of cars had been allowed to follow the cost-of-living curve since 1914, the people who bought automobiles last year would have had to pay 3,000,000,000 dollars more for them than they did. This saving does not take into account the marvelous improvement in cars which did not cost the customer anything.

The third way in which the constant experimentation that gave us the motor car has helped people is in the fact that at least one out of every five or six people who now have a job owes it to the motor car. The automobile industry itself either directly or indirectly gives employment to 4,500,000 people. The petroleum industry employs more than a million people, the motor car having caused it to expand 15-fold since 1900. Partly on account of the iron and steel needed for cars, for roads and bridges, and for buildings to serve the automobile, the iron and steel industry has expanded to more than 10 times its size in 1900, so that it now employs about 3,500,000 people. Besides the workers mentioned, there are all those who are employed on railroads, in telephone exchanges, in stores, in offices, in schools, and in fact everywhere, who would not have jobs if it were not for the stimulus that the motor car has given to industry. And remember that, without research, we would not have had the motor car at all.

How much improvement in automobiles will be made within the next ten years? It is impossible to tell exactly, for as the automobile keeps getting better, more and more effort is required to improve it further. But the motor car has not yet reached the final stage of perfection by any means, and more research and experimentation are going on in the automobile industry now than ever before. This research is also better organized than at any time in the past. Hence, there is every reason to suppose that, if one of the best of our 1930 motor cars were to be sealed up in a glass case now, the customer of 1940 would not think it worth any more by the standards which will have been set for automobiles by that time than we today think the 1920 car is worth.

¶ *Of the researches necessary to produce and constantly improve modern cars, the foregoing discusses a varied but principally pre-production class. Elsewhere in this issue, other researches vital to the industry are discussed. The article on page 18 outlines the value to the automotive engineer of the races on the Indianapolis Speedway, the front-drive car described on page 28 having been conceived there. Exhaustive "proving-up" tests of new improvements, such as those discussed on page 46, are necessary. On page 60 are described the researches in gasoline that have made possible the design of higher powered engines and have assured for the motorist fuel of a definite high quality.*—The Editor.



A TROUBLESOME NOISE IN YOUR CAR?

Automobile research engineers not only locate the noise but must also measure exactly how loud it is and determine its frequency and character. Radio is a tool in this difficult work

OUR POINT OF VIEW

Game Bird Laws

ATTACKING the Bureau of Biological Survey for its policies relative to duck hunting seems to have become the favorite indoor sport of certain individuals and a section of the outdoor press. And, unfortunately, their clamor has a quality of apparent plausibility which readily deceives the uninformed.

Recent criticisms of the Bureau by these too-conservative conservationists and sentimentalists might lead us to infer that our water fowl are practically extinct, were our credulity not tempered with judgment. They would have us believe that the only way to save them is to do away with duck clubs and increase other phases of duck-shooting "verbotens." They threaten to force federal legislation to carry their point.

Incongruous with these criticisms is the fact that hunters in various sections report greater numbers of water fowl this year than have been seen before for many years. Instead of nearing extinction, ducks are apparently increasing; and, while we, also, protest *needless* slaughter of them, they are, after all, game birds.

The Bureau of Biological Survey, after sane consideration, may consider justifiable the modification of certain regulations relative to the shooting of these birds. If so, any policy agreed upon by the Biological Survey and its advisory board should be sustained. It has demonstrated its worth and ability as an institution and has gained the confidence and respect of every game department in the United States. We do not believe its policies are now, or ever will be, open to thoughtless criticism, or should be menaced by any clique seeking merely "their way."

We Get Bumped

SUPPOSE one were to request the first half dozen people he encountered to name the most inventive nation. Suppose about six of these half dozen were to reply, "Why, we are, of course—haven't you ever heard of Yankee inventiveness?" And then suppose you were to reply that we rank twelfth among the nations in this particular quality.

Facts are facts, despite the natural bias of all humans in favor of whatever is their own. Professor Mark Jefferson, well-known writer and authority on the distribution of population and on other statistical studies of the human race, has published in the *Geographical Review*, quarterly journal of the American Geographical Society, the interesting outcome of his research on the "geographical distribution of inventiveness." His findings do not flatter our national self love. He has found that the leader in inventiveness is Switzerland. "The facts," he says, "are overwhelming." Switzerland, he adds parenthetically, is a world leader in broader respects than inventiveness, a fact which he attributes largely to that country having long been an asylum which has received thousands of the persecuted intelligentsia of other lands. Such people usually possess the quality of originality, for various manifestations of which they are or were persecuted. Originality finds one outlet in invention.

Getting down to concrete figures Professor Jefferson finds the Swiss people, man for man, more than three times as inventive as the Germans, four times as inventive as the French, five times as inventive as the British, and nearly six times as inventive as we Americans.

It may harm us little in the long run thus to have our complacency bumped. "Yankee inventiveness" is a well established term and in itself it is an accurate one. But the noun is not the exclusive possession of the adjective.

A Worthy Cause

AT the time this issue reaches you, a few days before Christmas, the joyous spirit of the holidays will be upon you, your petty troubles will be forgotten, and the chances are that you will be happy. In the vast majority of homes, gayety, laughter, and song will reign for days, but in a not inconsiderable number where reside the families of men in prison there will be desolation, heartaches, cold, and hunger.

The tremendous social problem of re-making criminals into useful citizens has been too often discussed to necessitate analysis here. We believe, to paraphrase a familiar quotation, that reformation of the criminal begins at home—his home. Kindness shown to members of his family is more likely to touch him than any amount of preaching; and sympathy and aid for them would do more toward inspiring him with hope and courage than the fear of prison bars.

The Volunteer Prison League of the Volunteers of America, Inc., are therefore performing a worthy service in extending practical help and kindly friendship, and in giving warm clothing, money, food, and toys to the families of prisoners. We heartily approve their work and urge that you do what you can to help, especially for the Christmas season, by sending contributions of the nature noted above to the League at 34 West 28th Street, New York City.

Unhealthful Noises

NOISES loud and screeching, noises strident, discordant, sporadic, and unrhythmic—the innumerable, nerve-racking noises of New York City are to be scientifically studied and, if possible, a solution for the problem outlined. The city health commissioner has appointed to perform the task a notable group composed of lawyers, physicians, engineers, builders, and neurologists.

In the sense that this problem has been studied in many places for decades, mainly as a nuisance problem for the police to handle, it is not a new one; but this is the first serious attempt to cope with it as a social problem. Old police regulations had to do with noises of horse-drawn street cars, carts rumbling over cobblestones, peanut-stand whistles, hucksters' cries, piano practicing, and singing. New regulations will have to consider such modern torturers as radio loudspeakers which make both day and night hideous with their cacophony of booms and shrieks from radio stores and a dozen nearby apartments, the riveting hammer, "rheumatic" motor trucks which rattle in every joint, sirens, and the thoughtless motorist who sounds his horn continually.

The influence on human health of the din assailing our ears has not been definitely established but it is generally agreed that insomniacs and neurotics suffer more acutely because of it; and it is logical to assume that it may cause such people to have nervous breakdowns. Likewise, noise may reasonably be said to cause nervousness and insomnia in people otherwise healthy. In either case, the result will be—aside from considerations of the effect of jarring sound waves impinging on the auditory nerves which is yet to be determined—a lowering of the vitality and powers of resistance to disease of the person concerned.

While there is no way of foretelling what results may come of the study now being conducted in New York City, we believe the efforts of the experts will not be in vain. Other urban centers would do well to follow suit in this worthy cause.

Air

About Good Air and Bad—Good and Bad Ventilating Systems. How Certain Not Very Ancient "Scientific" Ventilating Principles Are Already Out of Date

By DONALD A. LAIRD, Ph.D., Sci.D.
Director, Colgate Psychological Laboratory

CITIZENS in about half of the United States are forced by law to live in air that is harmful. Recent laws, based upon half formed scientific theories of a century ago, keep hundreds of thousands of Americans breathing and living in air that injures health and diminishes working capacity. Theaters, public schools, and factories in nearly half of the states are required by statues to use systems of ventilation which are not only wasteful in money but in vitality and efficiency as well.

Colds, circulatory disorders, catarrhal conditions, and even digestive disturbances are traced rather directly and surely by scientists to bad air conditions. Air does not contribute to these by carrying germs, for it is well proved that one of the best ways to kill germs is to get them into fresh air. There are no air-borne germs that should be seriously considered. It is something more complicated than simply germs that is responsible for the ill-effects of much of the air with which we are surrounded.

In observations on 5500 school children under different air conditions, for example, it was found that those spending the school day in rooms with temperatures from 59 to 67 degrees had 70 percent fewer colds than pupils of the same age and status who were in mechanically ventilated rooms with a temperature from 68 to 69 degrees. The children with fewer colds were in the colder rooms, and in rooms with only natural window ventilation.

AT a temperature of 80 degrees school children are reported as "restless, dull, and incapable of continued mental effort." At a slightly cooler temperature of 76 degrees they are dull, sleepy, and have poor penmanship. When the temperature is reduced to 70 degrees they are reported as "doing excellent work, and with cheerfulness in class." Best work is reported at a temperature of 68 degrees. When the temperature is lowered to 66 degrees splendid work is still done, but they begin to complain about the cold, while 60 degrees is too cold for good work.

When the room temperature rises above 68 degrees the body becomes feverish, we breathe more rapidly, the heart beats faster, and in a short time the blood-vessels become weakened. The temperature does not have to rise much above this level for these ill-effects to become apparent. Why, then, is not summer the most hazardous time of the year? The answer which soon will be clear is that, for many, it *is* the most hazardous.

ILLEGAL THOUGH EFFECTIVE

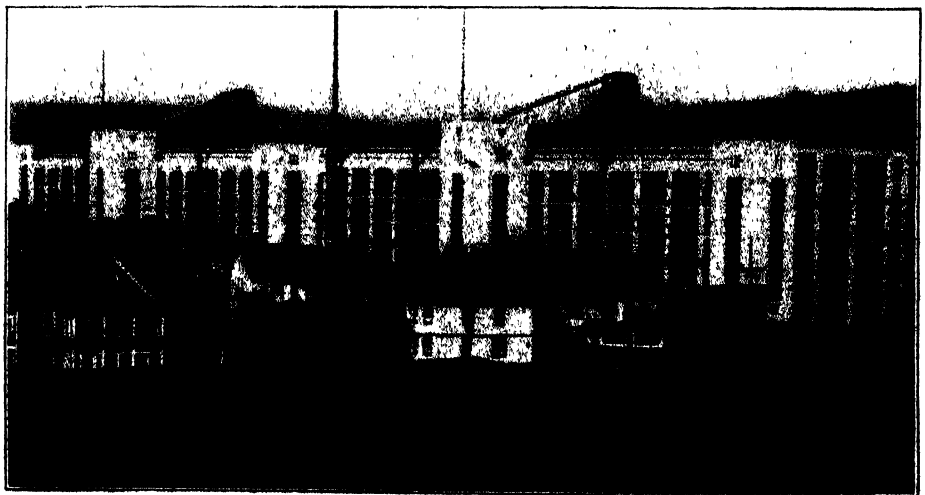
This exhaust hood would be illegal in some states, though it removes the gases

What is there about air that causes all this, and more too? We have seen that it is not germs and bacteria. Are there poisons in the air?

There is the famous and appalling case of the ship *Londonderry* which was bound for Liverpool with 200 passengers on board shortly before the Civil War. They ran into a severe storm and the captain ordered the passengers into the steerage cabin, no larger than an ordinary living room, where presumably they would be safe below decks. Shortly after the episode a writer, Edward Jarvis, described the ensuing events as follows:

"Into this small space the passengers were crowded; they would have suffered inconvenience if the hatches had been left open but the captain ordered these closed, and ordered a tarpaulin to be thrown over the entrance to the cabin and fastened down. The wretched passengers were now condemned to breathe over and over again the same air. This soon became intolerable. Then occurred a horrible scene of frenzy and violence, amid the groans of the expiring and the curses of the more robust; this was stopped only by one of the men contriving to force his way on deck and to alarm the mate who was called to a fearful spectacle. Seventy-two were already dead, their bodies were convulsed, the blood starting from their eyes, nostrils, and ears."

ALMOST a century before the *Londonderry* tradegy another catastrophe of bad air occurred. The Nawab of Bengal has just captured Fort William in Calcutta and his men forced 146 European men as prisoners into a guard room scarcely 20 feet



AIR CONDITIONING AND DUST REMOVING EQUIPMENT

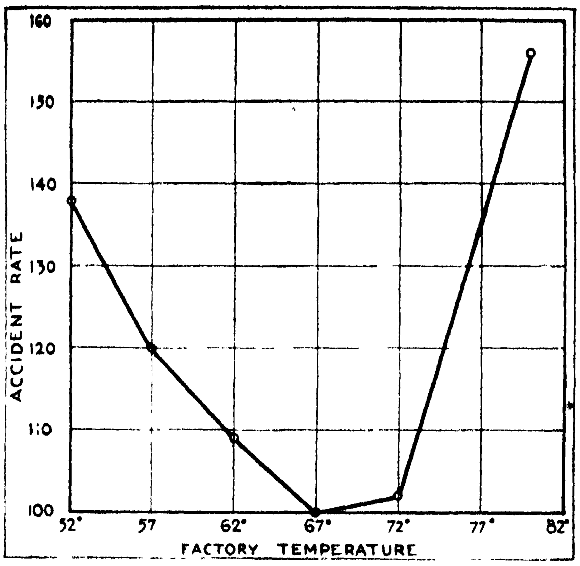
At a plant of the Endicott-Johnson Shoe Company. Modern industrialists install modern protection for workers to get larger output; also because of an enlightened point of view square, provided with only two small, strongly barred windows. A description of the outcome runs:

"Very soon after they were crowded in, an almost incredibly profuse perspiration broke out upon them, which was followed by consuming and increasing thirst. They became furious and goaded their guards with insults to provoke them to fire, in which they failed. They made furious cries for water; a little of it was brought to them in hats and forced through the bars. The stronger forced their way to the window and bore down and trampled to death the weaker ones. By half-past eleven the living were outrageous and quite ungovernable. At six in the morning the order arrived for their release. At that time only 23 were left alive!"

THESE two tragedies gave rise to the belief that human beings give off a poison which contaminates air. In all scientific grandeur the name of "anthropoxin" was given to this mysterious toxin. Now it is definitely known that air does not become poisoned by being rebreathed. It does have seriously bad effects, but not from being poisoned. There is no "air-borne infection," and there is no "crowd poison," to consider in obtaining the right kind of air to promote health and diminish fatigue.

The mythical anthropoxin gave way to a very real carbon dioxide in 1863 when the German scientist Pettenkofer announced that he had devised a method of measuring the carbon dioxide in air exhaled from the lungs. A century before this demonstration the French scientist Lavoisier had discovered the presence of atmospheric carbon dioxide, and with Pettenkoffer's actual measurement of carbon dioxide in the air exhaled from the lungs and finding 100 times as large a percentage in the lung air as in outdoor air, it began to appear as if carbon dioxide were the culprit. But carbon dioxide is not the culprit.

It is true that outdoor air contains less than one tenth of one percent of carbon dioxide, while after the same air is exhaled from the lungs it may contain as much as five percent of the gas. However, it looked suspiciously as though crowd poison was carbon dioxide, and at the turn of the century a wave of legislation started which required public and work places to be mechanically ventilated with exhaust ducts near the floor. Carbon dioxide being heavier than air mixture, it was evident that it would be near the floor and that exhaust ducts pumping out the air from near the floor would quickly remove any excess carbon dioxide. All this is true, but is very unsound ventilating practice for two vital reasons.



TEMPERATURE AND ACCIDENTS

The curve shows that the optimum temperature is 67 degrees; above this and below accidents increase

CARBON DIOXIDE:

In pure, outdoors air	0.040 percent
In air in lungs	5.0 percent
In air in worst ventilated rooms	0.40 percent

SUGGESTED TEMPERATURE STANDARDS:

Offices, drafting rooms, sedentary tasks 67 to 69 degrees F.
Rooms where workers are moderately active and move about . . 65 to 67 degrees F.
Foundries, blacksmith shops, carpenter shops . . . . 55 to 65 degrees F.

NOTE: These temperatures are high unless the air is also in motion.

TEMPERATURES OBSERVED IN WORK PLACES:

Bakeries	**90 degrees F.**
Laundries	**95 degrees F.**
Sugar refinery	**110-115 degrees F.**
Copper reduction	**100 degrees F.**

SCHOOL-ROOM TEMPERATURES IN 278 ROOMS IN 31 CITIES:

Temperature	***Percent of rooms***
Below 66	**6**
66-70	**40**
71-75	**37**
Over 76	**17**

FOR one thing, never in the course of ordinary events is carbon dioxide a menace, not even in the Black Hole of Calcutta or in the steerage cabin of the *Londonderry;* in fact more than 2 percent of carbon dioxide must be in the bottoms of the lungs to stimulate the respiratory center in the base of the brain which starts and stops the breathing action. The air in even poorly ventilated mines seldom has more than 3 percent of carbon dioxide in it. If carbon dioxide is a poison, then our lungs perpetually are filled with the most poisonous air.

For the second reason; having the exhaust ducts close to the floor results in pumping down to breathing level the air in the room which actually *is* harmful. If any air in a room is harmful to a human being it is the air near the ceiling. A floor-level duct brings this more harmful air directly to the inhabitants of the room. Yet Massachusetts and more than 20 other states demand by statute that their public buildings and work places be ventilated by mechanical systems which exhaust the air at floor level. Thereby they actually add to the perniciousness of the condition.

We are now closer to what has been demonstrated amply as the really undesirable conditions that make air bad for us. The demonstrated truth now is that it is not the air in our lungs but the air next to our skin which is responsible for the effects, whether they be good or bad.

One of the first scientific demonstrations of this fact was dramatic. An airtight room just large enough to accomodate one adult man was built in a German laboratory. Three rubber-covered port-holes were built into the side walls about five feet from floor level. An assistant in the laboratory was placed inside this experimental chamber where he had to breathe the same air over and over again. He gradually became fatigued, drowsy, slightly sick to his stomach, and finally was on the verge of fainting. Then he stuck his head through one of the rubber-covered port holes to breathe the fresh outside air. At the same instant two other assistants who were on the outside of the test chamber stuck their heads through portholes into the chamber, so they were breathing the chamber air into their lungs — one man in the stuffy chamber breathing fresh outside air and two men outside breathing the stuffy air of the experimental chamber. The two breathing the "poisoned" chamber air rich in carbon dioxide did not suffer at all, but the man breathing the fresh air while his body was enveloped in the stuffy, hot damp air of the chamber fainted dead away! His lungs were getting fresh, pure air, but his body was encased in air which it itself had made hot and humid.

IT is the cooling power of the air surrounding our bodies, rather than the purity of air within our lungs, that causes the damage.

In maintaining life and in doing work the body is the scene of ceaseless chemical reactions. Calories of heat are produced and lost. Through it all is the miracle of the body automatically keeping its own temperature close to 98.6 degrees. Whenever the temperature of the air surrounding the body rises it throws an excess load on the mechanisms within the body which regulate the loss of bodily heat, so that the normal 98.6 temperature is maintained. Whenever the room temperature goes even slightly above 68 degrees, normally clothed individuals have a taxing burden thrown upon the mechanisms which dissipate their self-formed heat.

When the room temperature becomes 75 degrees the following happens in the struggle of the body to maintain its internal temperature regulation: the heart rate is increased, the walls of the blood vessels relax, the delicate linings of the nasal and throat passages are noticeably and unfavorably affected, the body is more susceptible to whatever poisons actually may be within it and, according to Dr. Leonard E. Hill, it demands an excess expenditure of nervous energy by the autonomic nervous system which keeps up the body tone and co-ordinates the activities of the glands and bowels. Air above 68 degrees cuts down the flood of oxygen-rich arterial blood in the nose and throat, diminishing the resistance of these tissues to the germs of respiratory disease which lodge there. This is largely why colds and pneumonia are more common among those who live in rooms which are heated to more than 68 degrees in winter. It is not the cold, bracing winter air that causes colds and pneumonia deaths; it is the over-heated rooms in which people live.

THAT does not mean that the wisest thing is to go with light underwear and no overcoat into a blizzard, as some health faddists claim. Cold outdoor temperatures are usually less injurious, however, because one can add clothing which will conserve the heat the body is producing, while temperatures above 68 can not be compensated for by clothing.

The brain and muscles suffer fatigue under temperatures above the critical point of 68—except for exceptional air conditions to be noted shortly—since the blood supply is automatically shunted largely to the skin where it will have the most cooling effect. With an increase in room temperature muscular strength decreases, the ability to memorize is diminished, and the rate of performing arithmetical calculations is slowed down, according to the experiments of A. Lehmann and R. H. Pederson. Records reported by H. M. Vernon to the Industrial Fatigue Research Board in England show that there is a 60 percent increase in accidents among men workers in the metal trades when the temperature reaches 80 degrees. The errors made by clerical workers also increase disastrously with rises in the room temperature.

The best air to work in is cool air. The healthiest air to live in is cool air.

Temperature alone does not tell all about air being cool. Probably everyone has had the experience of standing beside a radiator or hot air register and actually shivering with the cold, although the temperature was almost enough to scorch him. The heat causes a rapid evaporation of surface moisture, and this has a cooling effect. A handful of gasoline feels cold because it is evaporating rapidly; a handful of ether feels colder because it evaporates still more rapidly. Dry heat is more cooling than moist heat, but the paradox is that a moist cold feels colder. The amount of moisture in the air affects its cooling power. Relative moisture content, or humidity, as well as temperature, is essential in gaging the cooling power or desirability of room air conditions. A fairly useful index of the effect of air conditions upon efficiency is to multiply temperature by humidity.

SCIENTIFIC EXHAUST FAN

The fan (note arrow and circle) is near the ceiling where it draws off bad air

AIR in motion is also cooling air. That is where the electric fan has its beneficial effect. It is also to the credit of summer weather that the high temperature is usually offset to a considerable extent by the cooling power of the air which is in motion. The draft from the electric fan is not as injurious as most persons believe; if, in truth, it is injurious at all. It is only the aged, tiny infants, and invalids that need to be worried in the least about drafts. It is not the engineer and fireman on the railway passenger train who catch cold from their draughty cab on the locomotive, it is the passengers in the draft-free and overheated coach that acquire colds for reasons we have already seen.

The more people shut themselves up in overheated houses to "avoid colds" the more likely they are to acquire the very thing they think they have shut out.

Temperature, humidity, and motion are the chief factors in refreshing air. It should be cool air rather than warm air; it should be slightly dry rather than damp; it should be moving rather than still air; and it should vary somewhat from time to time.

This last factor of variability was attained excellently by pioneer heating apparatus—perhaps too well attained. Thermostatically controlled heat which maintains a temperature uniform to a half degree may be comforting, but it is lacking in stimulation. It presents the opposite extreme to alternately roasting and freezing in front of a log fire.

The lassitude known as "spring fever" is seriously attributed by many workers in these fields to be due to the lack of variability. A variability up and down the thermometer of five degrees is invigorating to health and stimulating to efficiency. Office workers in artificial climates kept at a uniform precision by thermostatic controls are half-way on the way toward spring fever. A walk outdoors at the noon hour, or throwing the windows wide open at intermittent periods, introduces some of the benefits of variabilty. A drop in temperature from 75 degrees to 64 degrees reduces the death rate by 10 percent!

"ELEPHANT AIR" is not necessarily bad air, although it is unpleasant and depressing air. Elephant air derives its name from the anecdote about the small boy who was invited to a birthday party a few weeks after having seen his first circus. Upon entering the home to which he had been invited he shouted with glee, "Oh! They're having a circus. I can smell the elephants."

The smell of the air is socially vital but it has no demonstrated health effects. Apparatus has been developed for infusing the air of a room with ozone to offset other odors, but to many the odor of ozone itself is distasteful. The claims that ozone also kills bacteria is not warranted, at least when in the concentrations at which it can be used in breathable dilutions. Chemists have developed perfumes with a multitude of scents to offset odors which are likely to occur under any ventilating system.

In replenishing the air in a room the most effective general plan is to arrange for room air to be exhausted from the top of the room. For the average room, to open one window at both top and bottom will provide a current system whereby outside air enters at the bottom, and the superheated air at the ceiling is exhausted from the top of the window. To reverse the direction of this stream is to bring the most ennervating air on to the inhabitants. Yet this is exactly what most legislation demands.

Hearing Without Ears

Bone-Conduction Equipment to Aid Partially Deaf Persons

By GEORGE BARTON FRENCH

MANY children with defective hearing have been regarded by both parents and teachers as being dull mentally, the real cause being deafness which remains unsuspected until perhaps 30 percent of the hearing capacity has been lost.

No effort seems to have been made to date to provide hard-of-hearing public school pupils with an efficient mechanical hearing-aid at a reasonable price to enable them to receive not only the benefit of education but also the benefit of the companionship of their fellow-pupils. These children are not only embarrassed during their training period but the affliction, uncared for, will increase with advancing years and interfere to a large extent, if not wholly, with their ability in later years to earn a comfortable livelihood.

Deafness, in the case of a pupil in school is one of life's greatest handicaps. The desire to help a blind pupil is uppermost in the heart of every other pupil not similarly afflicted, but no such consideration goes out to the hard-of-hearing pupil from his or her school-mates.

VERY frequently, in the attitude of companions toward a deafened boy or girl, there is an exhibition of impatience, even resulting sometimes in a manifest desire to shun his or her society. In turn, the effect on these unfortunates is to make them impatient, suspicious, and fearful that they are objects of ridicule. The inevitable outcome is a sense of extreme despair. And these same truths apply with increased force to people who have advanced further in life with this same handicap.

Surveys show that there are in excess of 10,000,000 people in the United States with defective hearing, including 3,000,000 school pupils in need of treatment and of an efficient hearing aid to enable them to keep up with their classes.

Provided the acoustic nerve terminals of the inner-ear are intact, people afflicted with middle-ear deafness may now hear perfectly by a method of sound-transmission referred to herein as bone-conduction, this statement applying even to those whose ear-drums have been extirpated. While the principle behind this method is known to every otologist (ear-specialist) who uses a tuning-fork to test audition, its application as a practical aid to hearing is new.

To explain the principle of bone-conduction, a brief reference to the human auditory apparatus is necessary. The inner-ear—the business end of hearing—begins its process with a membrane called the oval window, on the inner side of which lies the labyrinth, a bony structure enclosing a colloidal fluid. The normal and sole purpose of the outer-ear and middle-ear is to cause this labyrinthine fluid to vibrate with the same frequency which existed in the original sound-waves impinging on the ear-drum of the outer-ear.

With a properly constructed bone-conduction receiver, it is now possible to vibrate this labyrinthine fluid without the use of any of the functions of the outer or middle-ear—practically a case of hearing without ears! The instruments employed are an electrical transmitter which replaces the outer-ear as a collector of air sound-waves, a bone-conduction receiver of special form which duplicates the functions of the middle-ear, an induction coil, and a dry battery, all of small size and weight.

The bone-conduction receiver may be placed in contact with any part of the head, preferably on the temple or mastoid bone. Its cover being thin and elastic, the vibrations of its diaphragm are transmitted with a minimum of loss through the skull to the bony structure of the labyrinth which, in turn, transmits the vibrations to the enclosed fluid.

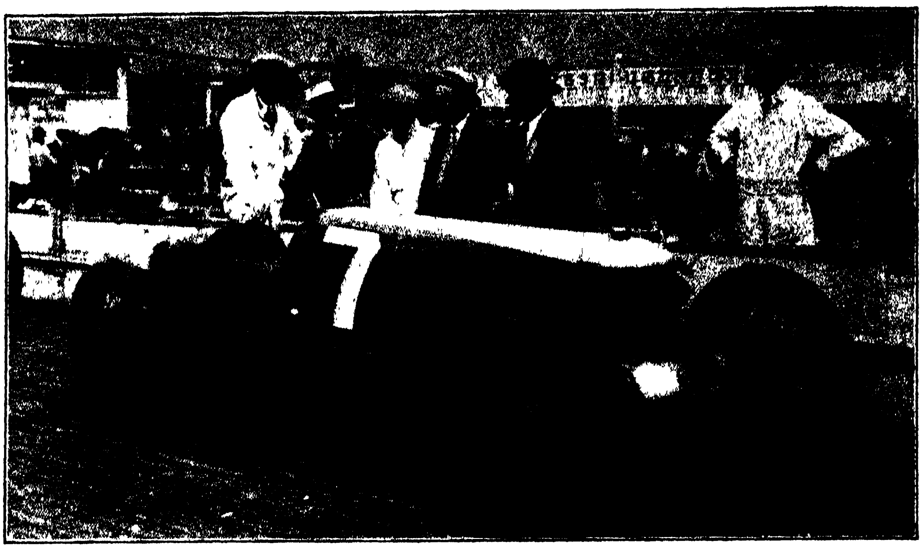
In hearing by bone-conduction, there is no possibility of damage to the auditory apparatus by reason of the sonority of sound-waves, such as always is present when the ear is closed by the pressure of a telephone receiver which leaves no path of escape to the outside air for the sound-waves reflected back from the ear-drum. Such a path is provided by nature in normal hearing. Deafened people should never allow the ear to be completely closed by a telephone receiver, especially if it is equipped with a tip or nipple which enters into and closes the ear-channel.

The most important application of the bone-conduction method of aiding audition is in the teaching of articulate speech and intonation to so-called deaf-mutes. These unfortunates, although in full possession of a normal vocal apparatus, are unable to speak words correctly for the simple reason that they do not hear the sound of their own voices and therefore are unable to make a comparison between the sounds of their own voices and those of their teachers' voices speaking the same words or sentences.

VOICE COMPARISON: TEACHER AND PUPIL

The author, at left, shows manner in which the bone-conduction equipment is used to teach "voice" to a deaf person

DEAF-MUTE children, however, except in rare cases where the acoustic nerve itself is impaired somewhere in its central course, have some degree of residual hearing. The problem has been how to reach it. Today this special bone-conduction receiver, transmitting sonorous wave vibrations through the skull, is able to vibrate the labyrinthine fluid to the extent of forcing the hitherto dormant acoustic nerve terminals of deaf-mutes to receive and to transmit the sensation of sound to the perceptive center of the brain. Recently the writer, using a special bone-conduction receiver, was able in less than a half-hour to teach a boy, who never before had heard the sound of human voice, how to pronounce correctly the entire alphabet, also several short sentences, including intonation of the latter. A new world was opened to him and his delight over being able, through his own efforts, to speak correctly by a comparison of sounds would, in itself, be a sufficient reward for the efforts of any teacher.



MILLER FRONT-DRIVE RACING CAR

Taken at the Altoona track, this photograph shows the Miller car and its designer, Harry Miller, second from the right; in the center is Dave Lewis, at left Harry Hartz, famous drivers

Developments Born of the Speedway

Perfection of Racing Cars and the Terrific Tests They Undergo Teach Many Lessons to the Manufacturer

By WILLIAM F. STURM *

WHEN the Indianapolis Motor Speedway Corporation put out its edict directly after the 1929 500-mile race, that the rules for the 1930 event would be changed radically, there arose a great deal of discussion, pro and con. This discussion took place, not only among the racing drivers, but among the personnel of the automobile factories and extended in ever-widening circles into public channels, for the Indianapolis race is one of the outstanding sporting events of the world.

The new rules are, briefly: That the piston displacement of the engines for the 1930 race shall be limited to a maximum of 366 cubic inches; that valves of the poppet type shall be limited to two per cylinder; that the centrifugal type of supercharger which has been used at Indianapolis and elsewhere on the racing circuit for six years (since it was first introduced at Indianapolis by the Duesenberg brothers) shall be dispensed with altogether; that not more than two carbureters shall be used on the engine; that the bodies of the racing cars shall be not less than 31 inches in width at the cockpit and shall be two-seaters; that the car shall weigh not less than 1750 pounds, with a minimum weight of 7½ pounds for each cubic inch of piston displacement.

These new rules mean that the present type of racing car will have to be sent to the scrap heap. In order to get the proper picture, it is necessary to compare the 1930 car specifications with those that have been in vogue at Indianapolis and elsewhere in organized racing, which is controlled by the Contest Board of the American Automobile Association.

Since and including the 1926 Indianapolis race, the piston displacement limit has been 91½ cubic inches; any type supercharger was permissible; there was no mention as to the number of carbureters; there was no specification as to the width of bodies; and there was no specification that compelled the driver to have other than a single-seater car, which all the racing pilots have had for years. The weight limit was fixed at a minimum of 1450 pounds, although there were few cars that weighed that little, even without gasoline, oil, water, and the driver, as the rules called for.

THE great question: "Why are all these changes necessary?" was hurled by the drivers into the supercharged discussional air that surrounded the Indianapolis motor speedway and the pilots. And in the answer to the question lies the primary reason for the change—a reason that has no bearing on the likes and dislikes of the drivers, nor on the attitude which the race-going public will take on the change. That these two sides of the question — which at first thought would be considered paramount—were not even considered by the men who drafted the rules, gets right at the root of the matter, as the officials of the Indianapolis Motor Speedway Corporation view racing.

According to Edward V. Rickenbacker, former speedway racing driver, war-time ace, and now the president of the Speedway Corporation and an automobile and airplane executive, "the 500-mile race has not been considered as a sporting event, per se, but as an effort on the part of the Speedway Corporation to aid the automobile industry to solve the problems that progressively confront it. It is for that reason that we are making the radical changes in the rules for the coming race. The rules, however, were not drafted by the speedway officials; they were written by members of the Contest Board of the A.A.A. and a group of other men selected from the automobile industry—men who would look at the problem in the light of the greatest good to the industry that made the speedway possible."

The Speedway Corporation has always put up rich purses for the drivers, first place being worth in prize and accessory money, from 30,000 to 40,000 dollars. It has always been a good investment for the driver to spare no expense to design and construct his car so that it would win the 500-mile race.

The motorist who switches on the ignition in his car at the curb, never gives a thought to it. Yet the well-nigh perfect ignition on the car of today is due in part to the demand of the racing driver that he have a type of ignition that would stand up under the grueling test of the 500-mile race. It is no secret at all that more than one Indianapolis race has been lost because of ignition trouble. And it is no secret, either, that one of the most successful types of ignition used in the automotive industry today was freed of many of its "bugs" through the extreme demands of racing.

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* See "Among Our Contributors," page 5.

The average car owner feels aggrieved if he can not take his car out on the paved highway and run it at high speed for hours. And he can do it, because much was learned from speedway racing concerning lubrication. A great part in the automobile engine of today is played by proper lubrication. The speedway races did much to develop the pressure-feed oiling systems that are found on the cars of today that go blithely on their way, day in and day out. The automobile industry profited through the racing driver's necessity, for the pilot had to have a system that would make lubrication positive.

Crystallization of metal used to play a certain amount of havoc with the automobile driver on the road. But if the man on the road had his troubles, what about the driver in the 500-mile race, hurtling along at 100 miles an hour over the rough two-and-a-half-mile course, with four corners to be negotiated in each lap of the track and with the rough brick course setting up more vibration in 500 miles than an ordinary road would in 5000 miles?

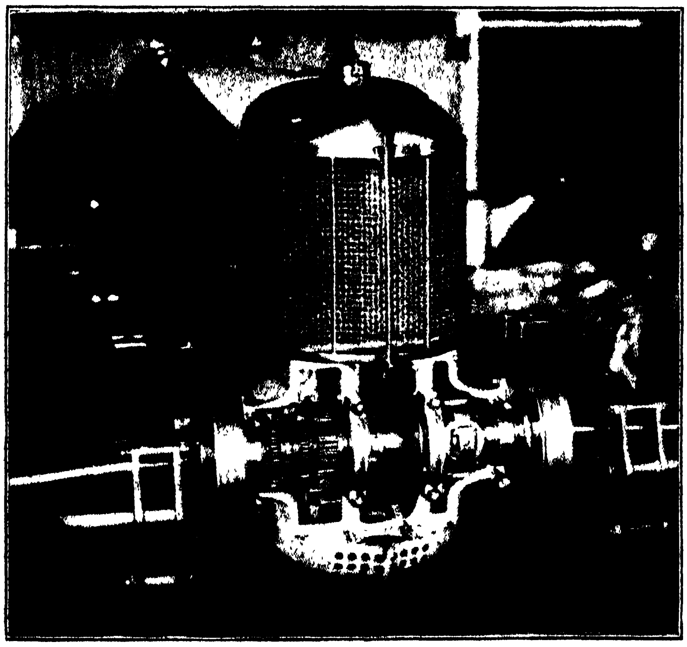
STEERING knuckles, steering arms, and front axles are three vital parts of an automobile, for if they get "fatigued" at the wrong spot in the journey the motorist may wind up in the hospital or the cemetery. For years the Indianapolis track was strewn with the wreckage of cars whose steering apparatus had failed. Today it is unusual for a wreck to be caused by such a fault. Why? Racing drivers have to have fatigue-proof metal, and what they have to have they eventually evolve or have evolved for them. The lessons learned in racing age for any one who cares to apply them.

Time was when a man thought he was "in clover" if he got 3000 miles of wear from his tires. Today tire factories promise ten times that distance and think little of it. The Indianapolis motor speedway has been one of the best testing grounds the factories have had. Tires that were developed for the 500-mile race have been of great aid in making a tire for commercial use that will withstand the high speed and the rough usage it receives at the hands of the driver of today's passenger car.

The difference between poor and good carburetion on the race course is often the difference between failure and success. Acceleration, an important function of the carbureter, is highly important at Indianapolis, with its four corners where the speed falls off and where it must be picked up again rapidly once the corners are negotiated.

IF one is inclined to doubt that carburetion and acceleration play an important part in the selling and using of cars on the street he need only "ask the man who owns one." No one wishes to run the risk of getting run over while driving across a street intersection by some up-to-date car with the proper acceleration; nor does he wish to be "left at the post" when the "GO" sign flashes.

The high-compression motor used by many factories today is a result of the need of the racing driver for an engine that would deliver the maximum of speed and not complain about the compelling power by vigorous knocking.



FRONT-DRIVE MECHANISM

Front end of the racing car in which Lewis finished second, 58 seconds behind the winner, at the Indianapolis Speedway in 1925

The "straight-eight" engine got its real test on the Indianapolis motor speedway, and its introducers in America, the Duesenberg brothers, actually combined their racing and passenger car engineering so successfully that their racing car still holds the 500-mile record at Indianapolis, while their passenger cars are recognized as among the fastest on the road. Other eights came along after the Duesenberg and one manufacturer even went to the extent of advertising that his eight was "born of the race track."

While four-wheel brakes are not so essential on the speedways as they are in road racing, Duesenberg, first American engineer to use four-wheel and hydraulic brakes, had his Indianapolis speedway cars equipped with them and gained much knowledge from their use there.

Racing cars, since the speed has risen higher and higher, have been designed with an eye to keeping them right side up. One of the essentials is a low center of gravity. A low center of gravity on the passenger car of today keeps it right side up on the road, where car speed now is faster than racing speed was only 20 years ago.

The Indianapolis Speedway did much for the present-day[*] front-drive automobile, which was first introduced in a race there in 1925 by Harry Miller, Los Angeles engineer. The first front-drive ran as faultlessly as could be, but as others were built and used they developed several bad "bugs" which it took years to eliminate. But the problems that confronted the front-drive were gradually solved under conditions much more rigorous than ever would be confronted on the road, and it was a racing engineer who developed the first passenger car of the breed. After two years of trying out, the front-drive has developed so far along the primrose path of automobile perfection that one of the most beautiful production cars of the present era is a front-drive. Another front-drive is now far on the road to success and production is expected to be started on it in a few months.

FOR all the years there has been an Indianapolis 500-mile race, there have been automobile factory engineers in attendance on it—car designers who come for a week before and stay for a week after the race. These engineers do not come out of mere idle curiosity; they come because they realize that racing is, in truth, the crucible of the automobile industry.

The Indianapolis Motor Speedway Corporation does not take all the credit for the development of the modern automobile. But in all the years that there has been an annual 500-mile race on the great brick course, the rules have pointed toward the one end—the greatest good to the development and experimental work of the automotive industry as a whole.

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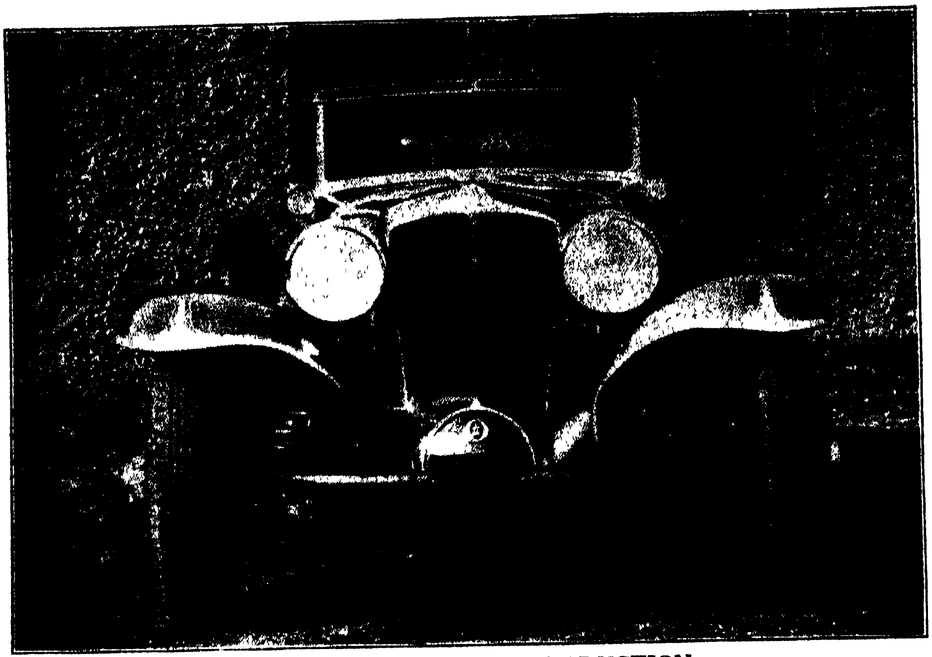
[*] Walter Christie built front-drive cars a score of years ago, but they were not made in any quantity, and soon faded from the automobile picture.

In 1911, when the first 500-mile race was run on the speedway, nine tenths of the production cars were of four-cylinder design, with huge engines—power plants whose pistons had a diameter of from five to seven inches and whose stroke was represented by the same figures. The power was derived from the great capacity of the cylinders and the combustion chamber, and this all made for a slow-moving, ponderous motor, which was considered "revving" at terrific speed if it reached 1800 revolutions a minute. The car was not "flexible," and this made for a lot of gear changing, as the least resistance to the car's forward movement meant a laboring engine, which called for an immediate shift into a lower gear. The oiling was of the splash type, that is, the cylinder walls and connecting rod bearings were lubricated by a spoon on the lower connecting rod bearing dipping into a shallow oil trough and literally splashing the oil to the parts needing lubrication.



NOW IN COMMERCIAL PRODUCTION

The front-drive principle, as applied to stock passenger automobiles, gives a rugged, clean-cut appearance. The illustration here is of the Cord car, described in detail on page 28

THE automobile as a whole and its individual parts were rather massive, for the industry had not yet learned that steering knuckles, axles, and other vital parts could be small and light as to weight, yet strong. The car was just a good big brute, with all the crudeness that one associates with a good big brute. And with it all, it sat well up in the air, and this height tended to make the center of gravity high and tended to make the car difficult to handle at speed.

Consider the car of today: The pistons are little more than half the size of the 1911 product. The combustion chamber is smaller and designed to handle higher compression than prevailed in the ancient cars. An engine that will respond on demand to a speed of 3600 revolutions per minute is not unusual. The oiling systems in a large degree are of the pressure type, designed to lubricate perfectly the bearings and the cylinder walls as the car floats along at from 50 to 90 miles an hour, in a way that never could have been done with the splash system, which considered itself overworked if it had to provide for a speed of 60 miles an hour for short distances, and whose operation depended a great deal on the car being fairly level for best results.

A great deal of attention has been paid to a low center of gravity in the present-day car. One has only to note the cars that go flashing by. Some of them seem actually to be rubbing the ground.

The car of the present moment is eight-cylindered, with experimental work going on in one or two factories for double that number. Multiple cylinders make for extreme flexibility. Gear changing is reduced to a minimum and one of the bugbears of women drivers is thus eliminated. The eight-cylindered car came to the Indianapolis track because the racing drivers recognized in its multiple cylinders something they needed in their business. It came into production because the manufacturers recognized in it something to fill a vital need.

After the 1911 and 1912 Indianapolis races had been run with cars of a piston displacement limit of 600 cubic inches, the speedway owners, with that rare vision that has made their race the wonder of the world, saw that the gravel and dirt roads would in time be giving way to those of the hard surface type. They foresaw the speed curve of the automobile rising higher and higher. They must have realized that in the nature of things the automobile would have to change to accommodate itself to the change in conditions under which it was to be used.

The then owners of the speedway, Carl G. Fisher, James A. Allison, Frank H. Wheeler, and A. C. Newby, had all prospered through the automobile industry and were due to prosper much in the future. They felt they owed the industry a debt of gratitude and the payment, they decided, was in the use of the speedway as a laboratory for the industry. In furtherance of this idea, they decided that the rules for all their races should be drafted so that they would anticipate by two or three years as nearly as possible the trend in the industry.

Accordingly, in 1913 and 1914 the piston displacement limit was set at 450 cubic inches, to anticipate the downward trend in the size of the automobile engine. At this time the race entries were all factory cars and in effect merely stripped-down stock cars.

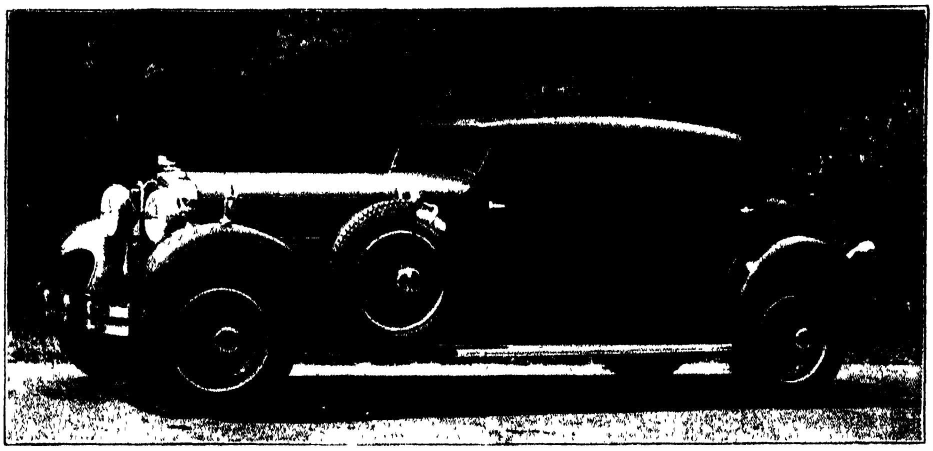
IN 1915, 1916, and 1919 (there were no races in 1917 and 1918, the war years) the piston displacement limit was reduced to 300 cubic inches. Factories still participated in the race, although not so heavily as in the early years. Whereas even stock parts were used on the early cars, now began a gradual change from stock parts to specialized parts where the racing strain was greatest.

The year 1920 ushered in the rule that the cars must be of 183 cubic inches displacement. This year saw the real beginning of the highly specialized, specially-built racing cars.

In 1923 the displacement was re-

HIGH AND AWKWARD

One of the first: Elwood Haynes, the automobile inventor, in his 1898 buggy-like car, a sputterer which stood high on its wheels



LOW-HUNG, RACY, WELL BALANCED

In this modern car many things learned on the race track have been incorporated. The Stutz here shown, and its companion, the Blackhawk, were almost literally born of the track

duced to 122 cubic inches and in 1926 this was changed still further downward to 91½ cubic inches, a quart and a pint, just half the size of the Ford motor of that day. That year, too, saw the inauguration of the one-man racing car.

There was a definite rise in the motor speed with the gradual decrease in the piston displacement. With 600 cubic inch cars the engine speed was approximately 1800 revolutions per minute, in rare cases 2000; the 450 cubic inch cars showed a rise to a top speed of 2300 revolutions; 300 cubic inches, 2800 to 3000 for four cylinder cars and 3500 for eights; 183 cubic inches, to as high as 4000; 122 cubic inches to a top of 5400; 91½ cubic inches to as high as 8400, with an average top of 7000.

It is true that the present-day manufacturers are not using such high engine speeds, but they are able to get much valuable information from such speeds.

When the Indianapolis Motor Speedway Corporation reduced its engine maximum size to 91½ cubic inches it felt that it had reduced it to the minimum, so far as benefit to the industry was concerned. It had, through the ingenuity of the racing drivers and the engineers who did the work for them, shown the automotive industry (1) that engines with a top motor speed of 7000 revolutions per minute were possible; (2) that lubrication could be had at those speeds; (3) that great horsepower could be obtained from small engines, as these small supercharged power plants developed in excess of 200 horsepower; (4) that reciprocating parts could be so well designed and balanced that they would perform satisfactorily at such high speeds; (5) that parts of the automobile that had to withstand great stresses could be built strongly, even though of light construction.

So long as a small high-speed engine would benefit the industry, the speedway clung to it. When the centrifugal type of supercharger was introduced and it was thought it would eventually be of use to the automobile manufacturer, the speedway aided in its development. Today it is known that the centrifugal type is not the supercharger to be put into the car that goes to the person in the street, because of its high speed—upward of 40,000 revolutions per minute on racing cars—and its delicate adjustment.

With hard paved, wide highways, and the demand for high speed in production cars, along with comfort, the demand has swung back along the trail. There will always be small cars and small power plants, it is true, just as there probably will always be four-cylinder cars in this class. But the medium-priced and the high-priced demand in America is for a car that approximates in size those of earlier days. The engines have not traveled so far along the backward road as have the cars themselves. High car speed and power may be had with a medium-sized motor, with high engine speed. These cars, with their multiple cylinders and other improvements, have all the flexibility to be attained with any engine, regardless of size.

With the demand, then, so well pronounced for a medium-size engine, the Indianapolis Motor Speedway Corporation, true to its tradition, feels that it must fall in line and aid in its development. It bans the small car, bans the supercharger, and asks the driver to get his carburetion from two carbureters instead of the eight that were used before the advent of the supercharger. Two carbureters are specified because that is the trend in the industry where eight-cylinder cars are concerned. The two-man body is added, because it more nearly approximates stock car design and the mechanician alongside the driver is expected to make racing safer, although this particular point may be open to question.

Now that the slow-speed, blower-type of supercharger, which runs at engine speed, instead of five times faster, is becoming a factor in cars that demand excess speed and excess power for heavy going, there is little doubt that the speedway may, in time, permit its use to aid the industry.

It may all be explained in one sentence: The Indianapolis Motor Speedway Corporation feels that its track can be of more use in developing the features that are part of the cars of today, than in continuing to race with the highly-specialized small-engined cars of the past that have given all they have to offer to the industry.

BROTHERS UNDER THE HOOD

A Duesenberg touring car of 1926 and, beside it, the Duesenberg racing car of that year. Duesenberg, a veteran racer, was the first American engineer to use four wheel brakes

¶ *An ocean covered the land; millions of minute sea animals died, sank to the bottom, and the embedded mass became marble when the water receded. Marble, the memorial stone, will be discussed in an article soon.*

Photo by Max Bégouen

ENTRANCE TO THE CAVE OF TUC D'AUDOUBERT IN SOUTHERN FRANCE

Access may be had only by means of a row boat in which one ascends the stream a short distance, then clambers up through a small opening. The cave was discovered on his own estates by Count Bégouen in 1912. It contains many treasured evidences of prehistoric man

When Reindeer Roamed the Pyrenees—II

How the Anthropologist Explores the Buried Evidence of the Ancient Past and Reconstructs an Outline of Prehistory

By IDA TREAT, Ph.D. (SORBONNE)

Co-author of "Primitive Hearths in the Pyrenees"

(Concluded from December 1929)

WHILE the sites of buried civilizations in Dordogne have for the most part been accurately mapped, there exists as yet no complete guide to the prehistoric underworld of the Little Pyrenees. Many "painted" caves have been discovered and explored and many Stone Age shelters excavated. But no one knows the exact limits of this portion of the cave man's country, for the whole district is honeycombed with caves.

THERE are caves with galleries vast as a cathedral nave and caves like rabbit-holes; caves that open gaping mouths in the hillside and caves completely choked at the entrance with earth and fallen rock; caves that consist of a single short tunnel, and labyrinth caves with dozens of branching passages. Some have long been known and explored; others no man has penetrated since the cave men left them; and still others for countless centuries have served as shelter only for wild animals—dens of the ancient cave bear and cave lion, and today the haunt of foxes.

Three of these caverns count among the great prehistoric art sanctuaries of France. First, the giant cave of Niaux that bores into the mountainside above the modern steel-town of Tarascon. There the visitor walks for over a mile through vast subterranean galleries of red and black-veined marble, coming at last to a chamber so lofty that the light of his acetylene lamp fails to reach the roof. At the top of a steep incline of sand he stands before one of the marvels of prehistoric art, a row of animal figures painted in black on the rock wall, startlingly life-like, a bison, horses, and a wild goat. In appearance, the paintings seem as fresh as if they had been traced there yesterday, but over them all lies a thin transparent "varnish"—a stalagmitic coating deposited there by the slow oozing of lime-charged water through the rock, a stony guarantee of their authenticity.

ENGRAVED BISON'S HEAD

From the cavern of Tuc d'Audoubert. Photographed by Max Bégouen

A FEW miles distant lie the twin caves of Tuc d'Audoubert and the Trois Frères, less spacious than the great cavern of Niaux, although the longer of the two is nearly a mile in length. Both are difficult of access. A subterranean river flows from the opening of the Tuc. To enter the Trois Frères, one must climb down a pit for over 100 feet at the end of a rope. Each cave consists of fairy-like chambers hung with snowy stalactites, low passages with barely space enough to crawl, and upper galleries which can be reached only by scaling vertical walls of rock.

The Trois Frères owes its renown to a series of 800 animal engravings and a strange figure that looks down from a high niche in one of the rock chambers—half man, half beast, perhaps the sorcerer or shaman of the cave man's tribe, or perhaps a strange god of this buried heathen world. The cave of Tuc d'Audoubert contains, together with many engraved drawings of animals, a unique example of prehistoric sculpture: two bison modeled in clay that today is as plastic as when the cave-artist laid aside his tools 300 centuries ago!

In these two caves as in no other, you realize that these underground art galleries were in no sense prehistoric habitations, but sanctuaries, hidden temples for the celebration of mysterious ceremonies and strange sacred rites. In one low chamber close by the modeled bison, you see hundreds of human footprints beneath a thin stalagmitic layer, footprints that go 'round and 'round as if in a primitive dance; while on the clay floor lie strange clay objects, modeled symbols of an ancient phallic cult.

Photo by Max Bégouen

ONE OF THE MODELED BISON OF TUC D' AUDOUBERT

It and a male bison figure, which does not show, no doubt had something to do with magic rites supposed to control the reproduction of the animals used for the ancient hunters' food

YOU can imagine the scene: the weird glare of smoking torches, the crouched, dancing figures—faces barred with paint, and bulky garments of skins; and perhaps standing by the modeled figures of the bison the sorcerer himself, masked and terrible, the artist and master of ceremonies.

Here too you can understand why the cave man did not dare venture often into the dark inner recesses of the cave. Driven from the entrance by the presence of man and his camp-fires, the cave bear no doubt continued to haunt the labyrinth of inner galleries. Today you see his traces everywhere—his clawmarks on rock and floor, the hollows in the soft clay where he slept, and the imprint of the furry haunches and paws of the great beast, a formidable adversary at close range for men armed only with weapons of flint and bone.

Photo by Max Bégouen

LITTLE BISON ENGRAVING

Also from Tuc. The prehistoric artist had a knowledge of form and posture that would do credit to modern art,

You may even conclude that the modern child's fear of the dark might well be a legacy from the cave ancestor to whom daylight or the glow of the camp-fire spelled safety, while darkness meant hostile, hungry beasts. The bold child or man who wandered away from the protecting flame risked a sudden and untimely end.

Aside from the three main sanctuaries there are other art caverns in the Plantaurel: Le Portel with its red horses and black bison; Montespan with its magic signs and crudely modeled clay figures; Gargas and its arabesque designs, its walls spattered with dozens of human handprints on a white or colored ground; and still other caves that contain isolated drawings, splotches of color or an occasional red arrow painted on the rock wall pointing to an upper passage or an inaccessible "chimney."

BUT the caves that sheltered the cave man are far more numerous than the painted sanctuaries. Like modern towns that cluster about their churches, so the settlements of the Cro-Magnons seem to have comprised a multitude of rock dwellings in proximity to a cave temple for the celebration of his magic cult. Not that dwellings nor sanctuary were necessarily permanent, since the nomad hunters must have shifted their settlements as the herds of game wandered from one part of the region to another. But wherever they camped, the temple of their primitive religion seems to have formed a part of the cave man's life, fully as essential as the cavern that sheltered the tribe and its camp-fires.

For at least 50 years scientists have turned their attention to the pre-

Photo by Max Bégouen

ENTRANCE TO THE CAVE OF TROIS FRERES

This cave, which is closely adjacent to the cave of Tuc d'Audoubert, was discovered in 1914 by Count Bégouen and named "Three Brothers" for his three young archeologist sons historic caves and shelters of the Plantaurel. They have discovered and explored painted caves and excavated the cave man's refuse heaps, removing the successive layers of ash, bone, and flint deposited there by Neandertal and Cro-Magnon man. But anyone who goes climbing today among the limestone ridges of the Plantaurel, pushing his way through the tangle of scrub oak and briar that masks the rocky slope, comes speedily to the conclusion that much of the prehistoric underworld still remains to be discovered.

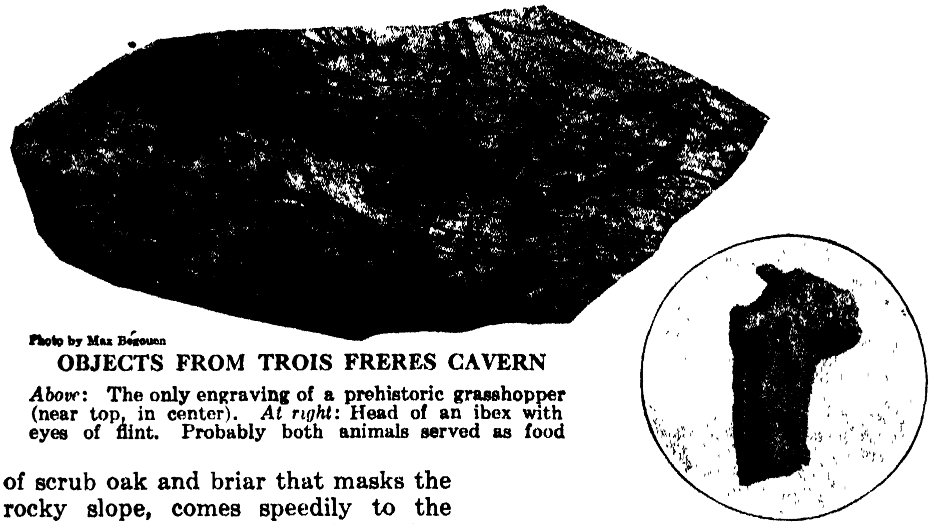


Photo by Max Bégouen

OBJECTS FROM TROIS FRERES CAVERN

Above: The only engraving of a prehistoric grasshopper (near top, in center). *At right*: Head of an ibex with eyes of flint. Probably both animals served as food

Since 1924, I have explored and dug in a part of the Plantaurel that lies about five miles distant from the great art caverns of Tuc d'Audoubert and the Trois Frères. In a district not more than 10 miles square, I have visited dozens of unexplored caves, their entrances for the most part hidden by underbrush or blocked with fallen rock.

ONLY a fraction of these had ever afforded shelter to Stone Age man who, I discovered, showed considerable similarity with the modern apartment hunter when he set about choosing his lodgings. He preferred commodious quarters, although not so vast as to be drafty, with wide openings to admit light and air, and wherever possible a sunny southern exposure. He liked caves that open on a broad terrace where in pleasant weather he could work and eat in the open; and he wished his water-supply close at hand. Such caves, I found, almost invariably contain traces of the cave man's presence and were occupied practically without interruption by the successive Stone Age populations. Caverns less favorably located sheltered intermittent guests; and some dark and drafty holes had served merely as an occasional night's lodging for groups of hunters. Of all the caves I visited, seven yielded prehistoric hearths. Three of these I have already excavated; the fourth cave is being dug.

Each time you enter an unexplored cavern, you look for two evidences of the cave man's presence—mural art and hearths. You advance slowly through the dark passages, holding your miner's lamp at arm's length and scrutinizing walls and roof for traces of color or the lines of an engraving. It takes no particular skill to detect a prehistoric painting on the rock wall, but you need a practiced eye to distinguish an engraved line from the natural cracks and fissures of the stone. Even when you succeed in making out a detail of the drawing it requires considerable focusing of the imperfect light before the whole design is visible in a complete and distinct outline. Often, too, the cave wall may be covered by a tangle of engraved figures, some standing on end, others lying on their backs—a confused interweaving of lines like a complicated puzzle.

No niche is too small to be examined. I remember one little horse no larger than the palm of a hand, exquisitely cut like an etched gem in a dark hollow of rock only a few inches above the cave floor. In an oven-like chamber so low that the artist must have worked lying on his back, the outline of a deer had been carefully engraved in the smooth limestone of the vault. As a general thing, spots which prove almost inaccessible to the modern explorer seem to have offered little difficulty to the prehistoric artist. It requires breakneck gymnastics to approach within reaching distance of the "sorcerer" in the cave of the Trois Frères; its creator must have clung like a fly to the vertical wall while he cut and painted the masked figure.

WHILE cave exploring in the Plantaurel does require a certain amount of acrobatics on the part of the visitor, it offers little actual risk. No more, in fact, than confronts the small boy who goes clambering among the rocks at the sea shore. The low passages through which you must crawl are generally smooth semicircular tunnels; in the larger galleries it is comparatively easy to avoid dangerous proximity to holes or rocks which look as if they might crash down at any moment.

The only really unpleasant caves are those that earthquakes have fissured and shaken into a chaotic disorder of rock and clay, but in these you risk little chance of discovering the cave man's trail. Disagreeable, too, are the "carrion" caves, pits into which the Pyrenees peasants have flung dead farm animals for many generations. Such caves you generally avoid, however keen your scientific curiosity, although it may happen—as it did once to myself—that while exploring a passage you may come upon such a pit. On that particular occasion, even before we realized the meaning of a heap of animal bones at the end of a long gallery, the flame of our lamps dwindled to a red spark from the lack of oxygen and we beat a hasty and undignified retreat.

Underground streams represent an

Photo by Max Bégouen

AN ENGRAVED REINDEER FROM THE CAVE OF TUC D'AUDOUBERT

The cave artist's tasks were not lightened by modern conveniences. His illumination was a flickering lamp (such as have been found); his tools were flint; smooth surfaces were rare inconvenience rather than a danger. Their volume in the Plantaurel district is rarely important, but the water is icy cold and to cross them means that you continue the exploration in clammy, sodden garments. If the water proves too deep to ford on foot, it is not over prudent to trust entirely to your ability as a swimmer. A couple of square gasoline cans make safe and convenient floats.

ASIDE from the prehistoric mural art which may, or even more frequently may not, be present on the cave walls, the explorer keeps an eye constantly on the cavern floor for traces of the cave man's hearths. For while Stone Age man did not inhabit the dark inner galleries, he occasionally built a fire there, perhaps to prepare a sacrificial meal. Frequently such hearths lie on the present surface, partially welded to the floor by a layer of stalagmitic deposit. Your light falls on a blackened stone or two, a few fragments of charred bone, a forgotten flint tool. It may be an engraving tool, the very *burin* that the cave artist used to cut the outline of an animal on the wall above!

Often, too, the primitive hearth stones may have been covered by a layer of clay brought there by water long after the days of Stone Age man. If so, the explorer's only resource is to dig. That is to say, you select a likely spot and make a "sounding." If lucky, you may happen on a hearth; more frequently however you encounter merely a layer of sand, stalagmitic material, or of flaked clay—the original "bear clay" of the cave bottom—that contains only the bones of the cave bear and his animal contemporaries, the cavern's earliest inhabitants. After a few fruitless attempts you generally give up the search for scattered hearths; their presence is always problematical and to find them would necessitate digging up the entire floor of the cave, an immense task.

Photo by St. Just-Péquart

OBJECTS FROM THIVIEC

A necklace and ornaments. These objects date very roughly about 10,000 B.C.

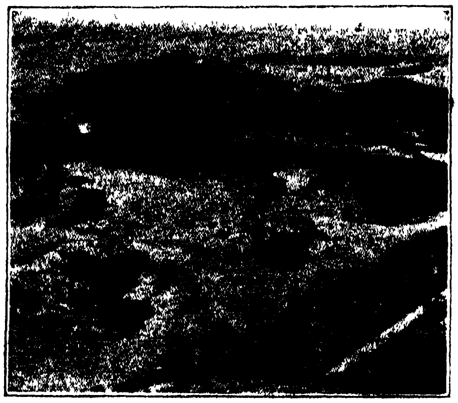
Back in the entrance chamber of the cavern there is always a much better chance of finding prehistoric hearths and refuse heaps. A systematic search shows that fires were sometimes built in the center of the chamber, sometimes against the walls; or if the cave had many occupants, hearths may be distributed over the entire floor. You do not find them on the surface. They lie beneath a layer of stone fragments weathered and fallen from the roof, and earth brought in from out-of-doors by water or the paws of animals. Or they may be sealed beneath a stalagmitic layer. In one cave of the Plantaurel—the cave of Gargas—the stalagmitic layer is in places 20 inches thick. The excavator cuts through it with quarrier's tools, lifts off the limestone blocks and underneath, welded together in a compact stony mass, lies the kitchen refuse left there by Cro-Magnon man 30,000 years ago.

In some of the more habitable caves, the digger finds heaped in successive layers the kitchen refuse of a complete series of Stone Age civilizations from Neandertal man to the Azilian fisher-folk. In others he may uncover traces of a single civilization. But in each layer, even though he may find no human bones, the animal remains and the type of flint and bone instruments tell in what civilization he is digging. A single flat harpoon says: "Azilian"; a fragment of reindeer antler means Cro-Magnon men; a triangular flint point and a rhinoceros tooth reveal the presence of the Neandertals. From the material taken from the ground and the carved and painted signs on the cave walls it is possible to reconstruct the history of the cavern through the long period when men of the Old Stone Age lived and hunted on the frozen steppe that today is southern France.

An occasional stroke of luck may bring to light an important discovery, but on the whole it is the painstaking every-day business of excavating that contributes the most valuable documents to the still incomplete record of the cave man's existence. The excavator's goal is not to find "museum pieces," although to dig up a fine bit of sculpture, a beautiful piece of chipped flint, or the bone of a hitherto unknown animal does represent the high-spots of his work. His task is to build up a careful cross-section of the far-away period from fragments which taken individually may appear quite unimportant.

"Stick to a site you know and dig it to the end," might be his motto. Indeed, the most important discoveries made in France within the past few years have come not from "wild-cat" prospectors for prehistoric treasure nor enthusiastic glory-hunters, but from men who for years have excavated—stone by stone and bit by bit of earth and clay—shelters and caves which, judged by their daily, weekly, or even monthly output, scarcely seemed to justify the effort.

Ten years of constant digging enabled Dr. Henri Martin to uncover a series of prehistoric burials and brought about the discovery of a sculptured stone frieze—bison, cattle, horses, and human figures—the most interesting example of the cave man's stone carving yet known. Careful excavations in an insignificant little cave of the Plantaurel led M. de St. Périer to find the little "Venus" of Lespugue, a tiny goddess of fecundity, the most beautiful of Stone Age images. Each year the patient work of Count Bégouen and his sons in the caves of Tuc d'Audoubert and the Trois Frères, and of M. Peyrony in the Dordogne région, bring to light new art objects carved in stone and bone by the primitive Cro-Magnon artist.



FINDS AT THIVIEC

At right: The prehistoric cemetery. Two skeletons and three hearths were found

THE most recent discovery of the bones of prehistoric man was made not in the cave country of the Pyrenees, but on an island off the Brittany coast. On the barren little isle of Thiviec, in a thin layer of soil never yet disturbed by a plow, Monsieur and Madame St. Just-Péquart uncovered almost on the surface a veritable prehistoric cemetery. Among heaps of ashes and kitchen refuse they found primitive "tombs" containing marvellously preserved human skeletons. A peculiar feature of these burials was that each skeleton lay crouched beneath a tent-like structure of deer antlers. An examination of the animal bones and flint tools that accompanied the burials showed that this prehistoric cemetery is older than the curious stone monuments, the menhirs and dolmens of Brittany, that it dates in fact from the last period of the Old Stone Age. The men who lay buried on the island of Thiviec belonged to a race similar if not identical to that of the Azilian cave men of the Pyrenees.

Hunting Pocket Planets

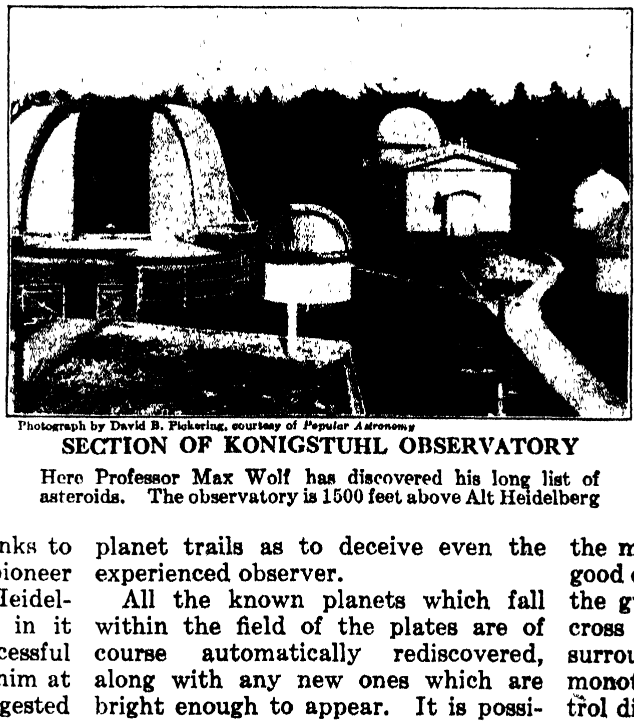
How the Astronomical Specialist Applies Scientific Management to the Systematic Search for New Asteroids or Minor Planets

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

IT is doubtful whether any man living could give from memory the names of all the known planets in our solar system. Many a reader may gasp at this statement and say to himself "Mercury, Venus . . ."; yes, every high school graduate knows or should know the eight large planets. But how about the thousand and more of small ones, the asteroids? The lore of classical, Teutonic, and Norse mythology has been well nigh exhausted in naming them; countries, cities, and universities have been commemorated, and to memorize the names which follow one another on a page or two of the list would be like recalling the names of the Pullman cars that leave a terminal station.

But before the tiniest planet can be named it must be discovered and its orbit worked out. In the old days of visual observation the search was most laborious. After making, through weary hours, a chart of all the faint stars in some region of the sky near the ecliptic where planets are likely to pass, the observer went over the region night after night hunting for stars not on the chart. In time he might find a moving body—a new planet. One enthusiastic amateur was so rewarded after 15 years of unsuccessful labor.



Photograph by David B. Pickering, courtesy of *Popular Astronomy*

SECTION OF KONIGSTUHL OBSERVATORY

Here Professor Max Wolf has discovered his long list of asteroids. The observatory is 1500 feet above Alt Heidelberg

BUT in modern times the discovery of planets has become a matter of "scientific management" and is done almost by machinery, thanks to the aid of photography. The pioneer in this work, Dr. Max Wolf, of Heidelberg, is still actively engaged in it after nearly 40 years of successful searching, and a recent visit to him at the Königstuhl Observatory suggested to the writer this present subject.

The asteroids are so small that they look exactly like stars, even with the greatest telescope. They may be distinguished from the thousands of faint stars which fill the field of the plate only by their motion. Fortunately this motion is fairly rapid, averaging about a quarter of a degree a day or half a minute of arc in an hour. If then an astronomical camera is directed toward the proper region and an exposure of two or three hours is made, following the stars carefully with the aid of a guiding telescope attached to the instrument the stars will appear on the negative as black dots, but the asteroid as a streak or trail which may immediately be picked out on inspection of the plate. All that is necessary is to pick out a likely region, preferably on the ecliptic and nearly opposite the sun, take the photograph and keep on again and again till the wished for trails appear.

A powerful instrument with a wide field of good definition is required and it is very desirable to have two such cameras mounted side by side on the same axis, as Dr. Wolf has. Then the reality of the faint trail may be confirmed "out of the mouths of two witnesses" and there will no longer be trouble from defects on the plate which occasionally look so much like planet trails as to deceive even the experienced observer.

All the known planets which fall within the field of the plates are of course automatically rediscovered, along with any new ones which are bright enough to appear. It is possible theoretically to calculate in advance where the known planets ought to be, but this is so much work that it is easier and cheaper to rediscover everything and then pick out the planets which are already known. This demands less calculation.

How things go at present is illustrated by the report of last year's work at Heidelberg. Sixty pairs of plates were taken by Dr. Reinmuth with a 16-inch double camera, and 139 single plates by Dr. Wolf with a 28-inch reflector. Upon these plates 99 new planets were discovered and 148 known ones re-observed. A comet was also discovered by Dr. Reinmuth.

It is evident that the asteroid seeker has still pretty good hunting. On the average 1¼ new planets were discovered for every pair of plates taken with the double camera. With the reflector, which has a much smaller field of good definition, one discovery was made for every five and a half plates taken, but these plates are of great value in recording the position and brightness of the very faint stars and so have additional scientific usefulness.

So far as the mere exposure time goes a planet was discovered for every two hours work with the camera and every four hours with the reflector. But this statement, while it shows to what an admirable degree of efficiency the asteroid work has been brought by years of experience, gives no idea at all of the amount of work which is involved.

SOMETIMES clouds come up and spoil promising beginnings. Moonlight fogs the plates so that no work can be done near the time of full moon. Clear moonless nights must be utilized to the full, although the flesh threatens rebellion.

There is a tale of a young assistant who, having completed two three-hour exposures on different regions, started in the small hours of the morning upon the third. With a good driving clock the task of watching the guide star and keeping it on the cross wires was not strenuous. The surrounding darkness and the steady monotonous clicking of the clock control did not encourage insomnia, and the observer knew no more till he was awakened by the rays of the morning sun shining faintly into the dome.

When the plates are taken and developed the heavy work is only begun. They must be most carefully examined under the microscope, going over every square millimeter of the image in order that nothing be missed. The new planets are all faint—if they were bright they would have been picked up in past years—and only an experienced observer can be sure that the faint trails are real. But suppose that a trail has been found, confirmed on the duplicate exposure and marked on the plate. Before the discovery can be of use to anyone else, the planet's exact position must be measured. This demands more work with a micrometer microscope, measuring not only the planet but neighboring stars whose places in the heavens are accurately known, and following up the measures by the necessary calculations.

Then the planet must be found again and observed on at least three nights if a rough orbit is to be calculated. With set fair weather this is not difficult, but only too often unfriendly clouds intervene or the full moon puts a stop to observation and when the next good chance comes the planet can not be found.

IT may have been receding from the earth and have grown fainter, or the rough idea of its motion gained from the original trace may not suffice to locate it after a fortnight. Anyway a considerable fraction of the newly discovered planets get lost again before the three requisite observations have been obtained, despite the best efforts of the observer. Sooner or later these lost planets are likely to be rediscovered and it is a commonplace to hear that a calculation reckoning back with the aid of the orbit finally computed from an adequate set of observations, has found that observations of "lost" planets in earlier years belong to the same body.

Planets get lost in another way, too. The observations of the first season are often insufficient to give anything better than a rough orbit, and if the planet is missed for a year or two thereafter the calculated position will no longer be good enough to tell where to point the camera. Some planets are thus lost for decades and then rediscovered. For example, an asteroid discovered in 1873 and named Aethra was lost in this fasion and only rediscovered in 1922, nearly half a century afterward.

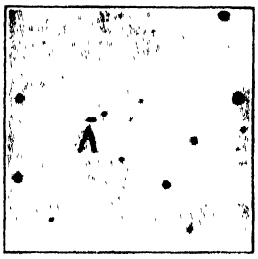
Photograph by David B. Pickering, courtesy of *Popular Astronomy*

DOUBLE 16-INCH CAMERA

Between the duplicate photographic refractors is a ten-inch finder for visual use

The number of "known" asteroids for which we have good, or at least fairly good, orbits now amounts to more than 1100. Yet two new ones are still discovered for every three old ones that the plates pick up. It is reasonable therefore to conclude that there are at least 700 more which await discovery. Making allowances for improvement in the methods of search it appears probable that the number of small planets in our lists will reach 2000 before the hunting becomes poor enough to discourage further searching.

Even then, the observers will still have plenty to do and the theoretical astronomers much more. The orbits of the asteroids come much nearer to Jupiter than do those of any of the larger planets, and the changes in the orbits produced by Jupiter's attraction are correspondingly great. An accurate calculation of the perturbations of one of these "little rocks" would in most cases be an enormous job. If it should be desired to predict the position as accurately as it can be observed, each of the 2000 asteroids would demand an amount of mathematical work which would average at least as great as that involved in the famous Lunar Theory. Roughly speaking one may guess that from 30 to 50 years work by a skilled mathematician with assistant computers would be required in a typical case. There is no fear, then, that the lovers of celestial mechanics will be in danger of idleness for centuries to come.


From Russell, Dugan and Stewart's "Astronomy,"
Courtesy of Ginn and Company

DISCOVERING AN ASTEROID

The technique is described in the text. Arrow points to asteroid's trail (retouched)

There might seem to be some fear that the asteroids would get quite out of hand and utterly outrun the powers of the calculators. But fortunately it is relatively easy (for a few experts!) to calculate the influence of Jupiter on an asteroid's motion, closely enough to predict its position in the sky within a few minutes of arc. With the aid of such tables we can be confident of finding the little planet again, even after letting it out of sight for 20 or 30 years. If we point our camera at the tabular position the asteroid may not turn up exactly at the center of the plate, but it will be safely *on* the plate and that is all we need to keep track of it.

Photograph by David B. Pickering, courtesy of *Popular Astronomy*

PROFESSOR MAX WOLF

"... with iron-gray hair and beard, twinkling eyes beneath bushy brows .."—D.B.P.

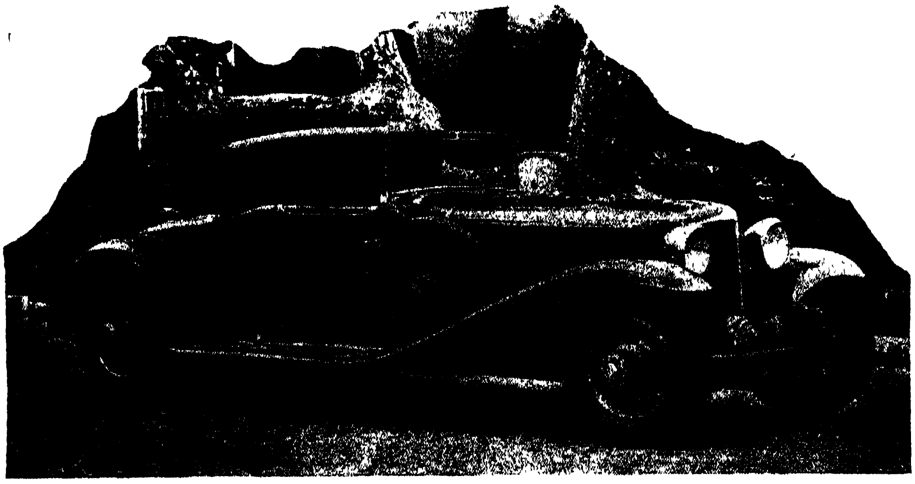
Observation of the small planets in this fashion should, so far as can be seen, keep a few observers busy indefinitely. The course of their work is likely still to be enlivened by occasional discoveries. A number of asteroids are known which move in very eccentric orbits and approach the earth's orbit closely on one side of the sun but are far away on the other. When such a body comes to opposition at or near its point of closest approach, it may be tolerably bright. When in the opposite part of its orbit, even at opposition it may appear 100 or even 1000 times fainter.

TWO or three such planets are known which are so small that they can be observed only in the favorable years of close approach. There must be many more that are undiscovered, and picking them up at one of the rare occasions when conditions are favorable may interest the observer of the future, after the general run of the less interesting planets have been accounted for.

It is impossible to conclude without a word of enthusiastic admiration for the courage, skill, and devotion to science which enable Prof. Wolf and his associates, in spite of severe limitations in the finances of their observatory, to discover planets at the rate of a hundred a year, and moreover to make other important contributions to the advancement of astronomy which there is not space to relate.—*Pontresina, Switzerland.*

An American Front-End-Drive Car

Many Advantages Seen for the Front-End Drive Which Has Recently Been Applied to an American Pleasure Car



THE CAR THAT "PULLS" ITSELF INSTEAD OF "PUSHING"

One model of the Cord automobile, the first stock American car to have front-end drive. Standing only 61 inches high, it is said to introduce greater safety and driving ease

INTRODUCTION by Auburn of the Cord front-drive automobile marks a new era in the automotive industry, in which America leads the world. While Europe took the first lead in the front-drive principle of automotive propulsion, limited production facilities and the smaller markets kept these cars from making great headway.

The history of the front-drive car in America is mostly a racing history, but it is replete with progress and accomplishment. Barney Oldfield as early as 1912 introduced the front-drive car to the American speedway, piling up many records with his car known as the "Christie," but it was left to Jimmy Murphy and Harry Miller to introduce the all-American front-drive car in 1924. Murphy died in that year, and the car was finished by Miller who entered it in the Indianapolis Speedway races Decoration Day, 1925. The car was driven by Dave Lewis and won second place (100.82 m.p.h.), in the fastest race ever held on the speedway.

Since that time the front-drive car has been a formidable contender in every major race in the country with such drivers at the wheels as Pete DePaola, Harry Hartz, Leon Duray, Cliff Woodbury, Pete Kreis, and Hepburn.

It is interesting to note the comment of Harry S. Miller on the reasons for his going over to the front-drive type racing car. He says:

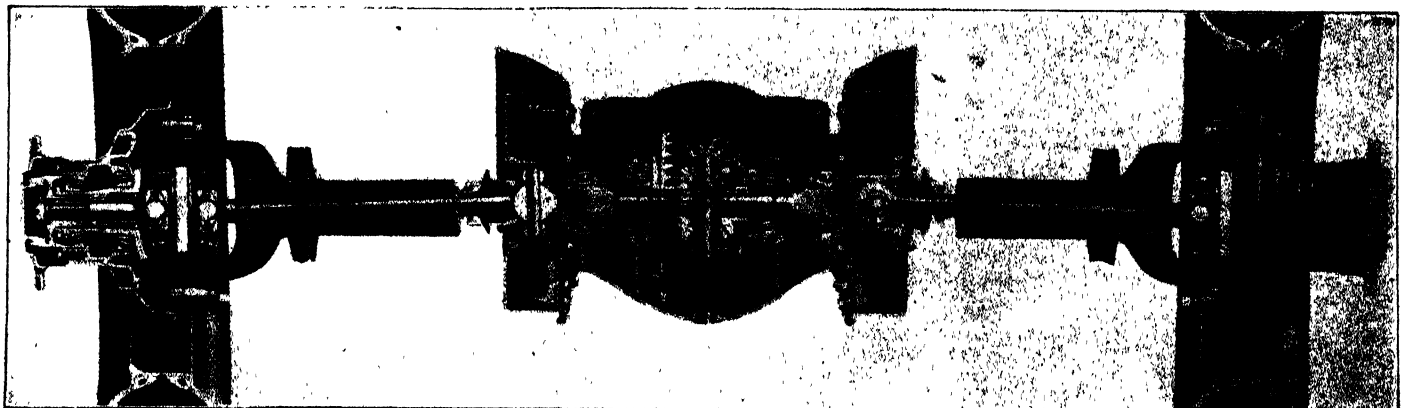
"I do not believe that the front-drive car is any faster than the rear-drive type. The reason why it can make better time on the speedways is that it is unnecessary for the drivers to slow down around corners, the skidding of the front-drive type being reduced to a minimum. The success of the front-drive car has been in the safety factors which it provides. It is a monumental record that in the five years front-drive cars have been used on the speedways there has never been a death due to one of these cars getting out of control."

While racing has its interest to the public, most car owners want to know what the front-drive has to offer them. The consensus of automotive engineers is that the chief contribution of the front-drive type automobile is, like that of the racing car, safety, with a second consideration of comfort, and possibly a third in economy. Three factors make possible the added safety of the front-drive car: its unusual lowness of design (it fairly hugs the ground), its lack of unsprung weight, and its "pulling" traction.

Some two years ago Harry Miller became associated with E. L. Cord, President of Auburn, in the production of a front-drive car. After eighteen months of experiments, with experimental cars on the roads day and night, the Cord front-drive car, built around the Miller patents, was announced.

PROBABLY the most noticeable feature of the new car is the closeness with which it hugs the ground, and yet it has a road clearance equal to most rear-drive cars. An ordinary size man standing beside it can look over the top. The phaeton-sedan, for instance, is only 61 inches high at the peak point, but even with this low construction head room is a full 38 inches. The average rear-drive sedan stands 70 to 73 inches with the same amount of head room.

Striking in appearance also is the long hood which is 46 inches in length, giving the car an unusually fleet and powerful appearance. The front fenders have an over-all length of 80 inches, and are the longest used on any production car. They are of the one-piece type and their long, sweeping lines add again to the fleet appearance. The

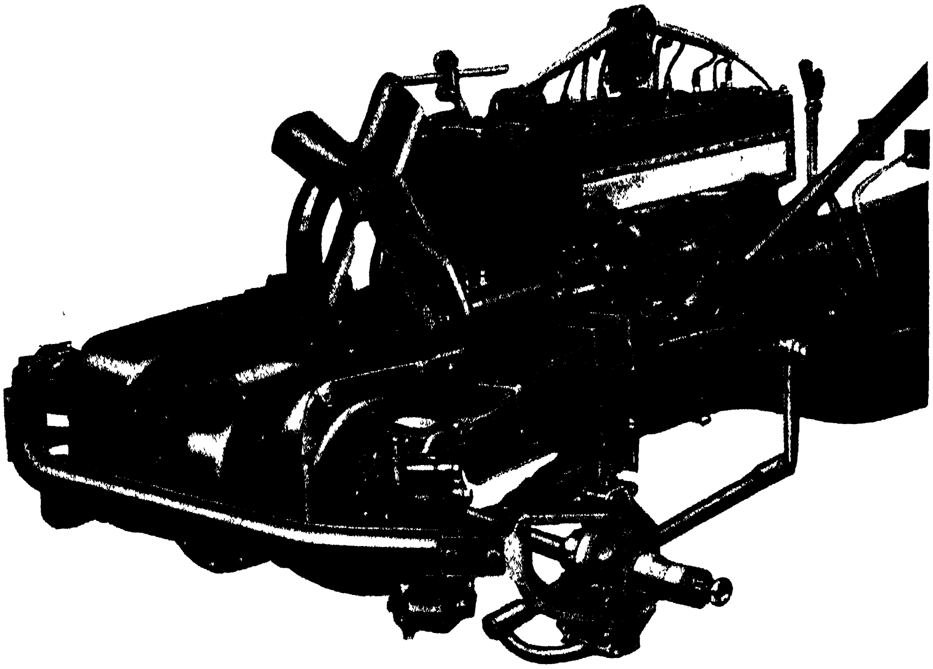


THE FRONT AXLE IS THREE QUARTER FLOATING

To transmit power to the front wheels and at the same time permit turning at a sharp angle presented a problem which the engineers finally worked out successfully by designing a special universal joint. Transmission, differential, and short drive-shaft are back of front axle radiator is of the "V" type similar to the design used on Miller racing cars, although much larger, with the top line of the hood practically parallel with the ground. The body itself is streamlined throughout, with the rear seat on the same level as the front.

From a mechanical and engineering standpoint the front axle and method of drive are of chief interest. With the new Cord front-drive the engine, the transmission, the drive shaft, the differential, and the driving axle become a single power unit, thus adding to the efficiency.

The front axle is three quarter floating, and consists of a latitudinally bowed tubular member joining the steering knuckles. The propeller shafts are entirely separate from this, entering only at the ends where the steering knuckles are attached. The transmission and differential are all located directly back of the front axle and are mounted on the frame of the car, becoming sprung weight.



THE POWER PLANT

Engine of the new front-drive car. Here will be seen manner in which all except front tubular axle has been made sprung weight. Note special universal and method of steering

UNIVERSAL joints are provided in the propeller shafts, the two inner ones being of the Universal Products type, and the two outer ones of a special constant velocity type patented and used for the first time by Auburn in the front-drive car. It is this special universal joint that has made the Cord car possible. Heretofore, designers of front-drive cars have been hampered by their inability to obtain a universal joint which would give constant velocity to the front wheels when making a turn. Race drivers who have used the front-drive cars were under the handicap of having to make wide turns. Through the use of this new type universal joint the turning radius of the car has been reduced to 21 feet, or less than that of any rear-drive car of the same wheelbase.

Another outstanding feature of this front axle is that the king pin is perpendicular and that no transverse inclination has been necessary. This permits the use of a longer king pin and greater bearing surface, resulting in easier steering.

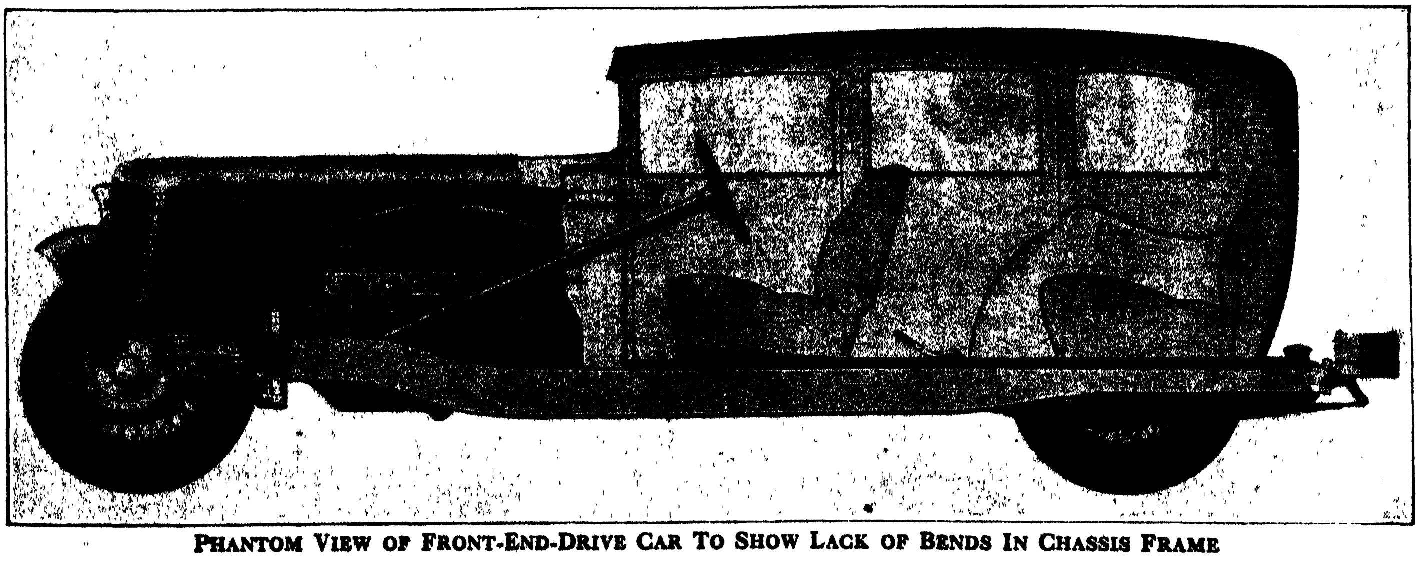
In detail, the car is powered by a straight-eight, 125 horsepower, Lycoming motor, which has been developed especially for this model. This engine is reversed from the usual type, the flywheel being in front, next to the transmission. The rear axle is of the I-beam type, and is approximately of the same weight as the front axle of the ordinary rear-drive car.

Brakes are Lockheed, 4-wheel internal expanding hydraulic, with a division of braking 60 in front and 40 in the rear. The emergency brake is operated by a hand lever well forward in the front compartment, and brakes on the rear wheels. The gear-shift lever extends through the instrument board and operates by a thrust turn.

The chassis frame has been made unusually strong, the channel stock being 7 by 3 by 7/32, and is unusually heavily reinforced by an X-cross bracing. Front springs are of the double quarter elliptic type, with the spring ends set in rubber. The rear spring is of the semi-elliptic type, and is built unusually rugged.

Through the elimination, at the rear, of the differential, transmission, and long drive shaft, it has been possible to design straight body sills, the elbow type of the rear-drive being unnecessary for the clearance of rear axle housings, which enables the rear of the body to be set much lower, the rear seat being on the same level as that of the front seat. The body of the car rides unusually low, and while the over-all height is considerably less than that of the rear-drive car, the head and leg room are greater. Average front head room is 38 inches and the rear 38 inches. The front seat is adjustable.

Four models are available, a Sedan, Phaeton-Sedan, Cabriolet, and a Brougham, all on a chassis of 137⅝-inch wheelbase.



PHANTOM VIEW OF FRONT-END-DRIVE CAR TO SHOW LACK OF BENDS IN CHASSIS FRAME

The Truth About Aviation Stocks

Basically Sound, the Aircraft Industry Has Suffered Severely From "Growing Pains," But Is Now Becoming Stable

By REGINALD M. CLEVELAND

AVIATION, that precocious infant among industries, which has leaped from the cradle to its majority—in performance at least—in less than half the time the human being requires to come of age, presents the anomaly of still suffering rather severely from growing pains.

In fact, in the last few months, these troublesome attendants upon growth have become severe. The industry, although fundamentally sound, and destined, in the belief of the writer, to have an even more important future than some of its rosiest protagonists have painted, is in a condition of confusion, of uncoordinated effort and, in many of its branches, of a very definite and disturbing over-production.

When, upon the impetus of the Lindbergh flight, and with the stimulation supplied by the gradual turning over of airmail operation by the Government into private hands, the industry quickly gained the immense momentum which has been manifested for the last year and a half, it was perhaps inevitable that it would build its house to some extent upon the shifting sands of dreams rather than upon the enduring rock of public service and patronage.

AVIATION securities, eagerly snapped up by an air-enthusiastic, if not truly air-minded, public, have come tumbling down in value. This does not refer to the spectacular events, the orgy of hysterical and distressed selling, which affected Wall Street in the closing week of October and saw aviation stocks tobogganing along with those of far longer established and more fundamental industries. I refer to a decline, less immediately impressive but more fundamentally disturbing, which took place, broadly speaking, all through the summer.

The performance of ten representative air stocks is reflected in the following table. The figures given are the high for the year and the low as of October 14, before the general avalanche of selling affected all stocks of whatever nature on the markets of the United States.

NEW YORK STOCK EXCHANGE

High		Oct. 14
20	Aviation Corp (Del.)	11½
104⅜	Bendix Aviation . .	65
37⅛	Curtiss-Wright A. .	27
48¼	National Air Trans.	20
162	United Aircraft . . .	106

NEW YORK CURB EXCHANGE

48½	Aero Underwriters.	29½
89⅞	Aviation Corp (the Americas)	40⅛
67½	Fokker Aircraft . . .	35½
18	Roosevelt Field, Inc.	6½
78¼	Western Air Express	44½

A study of other aviation securities would reflect a like general tendency.

IT is not contended that all of the losses in values shown were justified. The worthy declined with the unworthy, due as much as anything, it may be, to an awakening on the part of the public to the fact that *gross* earnings from manufactures, plus those derived from the transportation of airmail and the irregularly profitable transportation of passengers, could hardly exceed, for the year 1929, the sum of 100,000,000 dollars out of which only *net* earnings would be applicable to an investment of close to 1,000,000,000 dollars.

It must not be supposed that, because the ratio of income to investment is so unalluring as yet for the industry as a whole, certain soundly organized and ably managed companies in the fields of both manufacture and transportation are not upon a healthy and profitable basis. The trouble has been that the sudden loosening of the purse strings of both the banks and the public, and their readiness to leap to the support of almost any or every enterprise which could be linked with aviation, has been far from an unmixed blessing. Altogether too many inexperienced persons and ill-conceived manufacturing and transportation programs have entered into the picture.

These must necessarily fall by the wayside. They are already doing so. Certain types of aircraft, notably the smaller planes unbacked by substantial performance records, remain unsold in hangars and stockrooms in many parts of the land. The state of overproduction is very definite.

Again, on the transport side of the picture, too many inexperienced operators, lured by the undoubted substantial profits which have been made in many instances in the transportation of airmail, have been led into the inauguration of passenger-carrying services. Some such services are already distinctly profitable. Many—one might almost say most—are not yet profitable, chiefly because the American public, while reading, talking, and thinking avidly of aviation, does not as yet take sufficiently to the air.

There can be but one result in a situation of this kind. The intelligently conceived, soundly managed, and well financed "strong" companies will survive. Those that do not have these characteristics, both in the manufacturing and in the transportation ends of the business, will cease to be. From the point of view of the investor it is a time for careful analysis and rigid selection in the purchase of aviation securities.

How far short the year 1929—in spite of overproduction in certain types—will fall, in comparison with the optimistic estimates which marked the beginning of the year, may be gathered from an examination of the comparative figures. The early estimates set the probable plane figure for the year at 12,000 to 15,000. There were actually manufactured in the first six months of 1929, according to the figures of the Aeronautical Chamber of Commerce, a total of 3381 airplanes (including 527 for military use) and 3826 engines (including 551 for military use).

THESE figures, which represent 93 percent of the industry, do not indicate a total production of planes exceeding 6500 to 7000 for the year, or of engines in greater number. The figures may be compared with a total representing 95 percent of the output of the industry for the year 1928, according to the Department of Commerce, of 4345 planes and 3496 engines—in both cases including the military.

It is estimated, according to statistical studies made by Air Investors, Inc., that 75 percent of all the industry's activities are carried on by less than ten companies. On the other hand, the Chamber of Commerce lists 278 companies claiming to be aircraft manufacturers. Of these it is possible that 200 will have manufactured some aircraft during the year. If 7000 units be taken as the total, this will bring an average production of 35 planes per manufacturer, obviously not a basis upon which profitable manufacturing could be carried on. The fact is that a handful of companies will of course have very much larger production than this average and that most of the rest will no longer be in the aircraft manufacturing business.

Looking to the sound future of aviation, it is probably very well indeed that the manufacturing estimates for 1929 will not be reached, for there are not pilots enough to man any such fleet of planes. On June 30, 1929, the number of licensed pilots was only 90 percent of the number of planes which had been licensed and identified by the Department of Commerce. In the 12 months ending on September 1, 17,350 applications for student pilot licenses were received by the Department. Of these applicants only 45 percent passed the physical test, completed their flying courses, and applied for pilot licenses, and only 26 percent, or 4570, received pilots' licenses. On September 1 there were 6891 licensed pilots as against a total of not less than 8000 planes.

Courtesy Boeing Air Transport System

ONLY THE STRONG CAN SURVIVE

Intelligently conceived, soundly managed, and well financed aircraft manufacturers will remain in the industry and will eventually show profits. All others will fall by the wayside

No one with the interest of aviation at heart could wish that licensed planes or unlicensed planes, for that matter, should be flown by unlicensed pilots. The very real and menacing bugaboo of aviation is the unlicensed pilot and the unlicensed plane. The leaders of the aviation industry quite rightly urge that the public, in reading the daily toll of airplane fatalities, should draw the sharpest kind of a line of demarkation between the crashes in which untrained personnel and unfit equipment are involved and the very small and constantly diminishing number of accidents involving trained personnel and proper equipment. It would indeed be hard to put too much stress upon this contrast, and one need only learn of such records as that, for example, of Western Air Express which has operated its passenger-carrying planes 3,200,000 miles without an accident, to realize how safe properly organized air transport can be.

IT goes without saying, then, that aviation could hardly be benefited by a great surplus of planes without an adequate number of trained pilots to operate them. It will be of vital importance to the industry to emphasize to a much larger body of men and women during the coming year the training points required by the wise provisions of the Department of Commerce.

In addition to overproduction, and to the deflation of security values, aviation has been forced, during recent months, to face the swallowing of two rather bitter pills: First, the probable reduction of the army and navy appropriations for aircraft by three million or four million dollars each; and second, a reduction in the rates paid to operators for the carrying of the airmail, or, at least, a very considerable readjustment of those rates.

The outlook for the industry, however, in the view of the writer, is a most favorable one. The recent period of readjustment, of that settling of the yeasty brew which inevitably follows such unusual expansions, was only to be expected. Painful as the process may have been, for individual concerns and for those persons who sought to capture a pot of easy gold at the end of the aviation rainbow without due analysis of its spectrum, it can only lead to a more substantial and a better founded structure.

There is no justification for pessimism in regard to aviation. From the point of view of manufacture, the strong companies are carrying out programs carefully and efficiently planned and buttressed by back-logs of orders which will keep their plants busy 80 to 90 percent of capacity for many months to come.

The most farseeing of the strong companies are reaching out well articulated tentacles into the export field. It is a field of immense promise, and no less an authority than Daniel Guggenheim, donor of 5,000,000 dollars to the advancement of aeronautics and of many times the value of that amount in the stimulation wrought by the Fund which he founded, predicted in a comprehensive article in *The New York Times* recently that aircraft and their accessories would come to be major factors in the export trade of the United States.

POWERFUL interests, heretofore outside or only remotely connected with the aviation industry, have manifested their more active interest by investment in aviation projects. Notable among the recent moves of this sort has been the formation by the General Motors Corporation, acting with the Fokker Aircraft Corporation—of which it owns practical control—of the American Dornier Corporation, to bring the manufacture of Dr. Claude Dornier's giant flying-boat types to the United States.

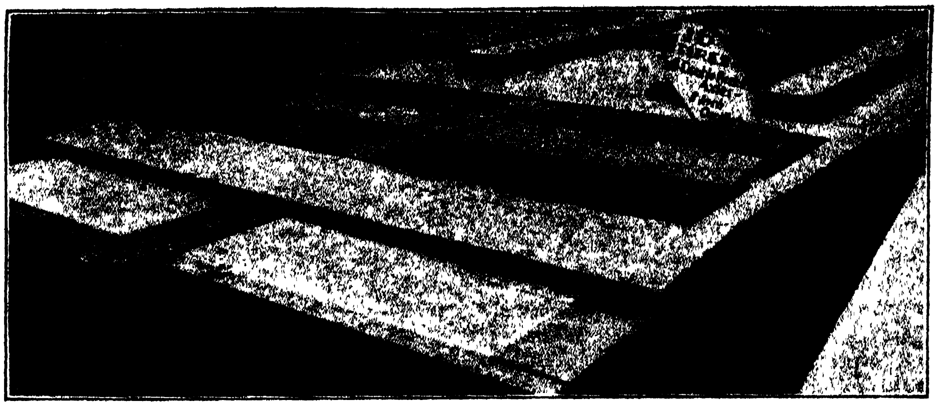
Pan-American Airways, after Colonel Lindbergh's latest line-charting trip, may be expected rapidly to bring the circle of the Caribbean into the scope of its expanding passenger transport. Meanwhile it has arranged a 30-hour service with air-rail hook-up between New York and Havana, and looks for such an influx of business on the Miami-Havana route that it is contemplating the use of the new giant Fokker *F-32* landplane for this popular flight.

Universal Air Lines and Western Air Express, acting together, will fly passengers from Atlantic to Pacific in about 30 hours.

Meantime, the dirigible *R-101* performs even better than had been expected in her early flights in Great Britain, and the "ring" has been laid for the first of the two super-dirigibles for the navy in the world's largest building, the new hangar of the Goodyear Zeppelin Company at Dayton.

Aviation, then, is very far from moribund. It is a strong young tree which has made too much wood for its own health. Some of that wood has been rotten, some of it has been merely superfluous. A drastic pruning has been in operation. The result will be a healthier growth.

Giant Trailers Protect Pavements



TRAILER FOR TRANSPORTING HEAVY CONSTRUCTION EQUIPMENT

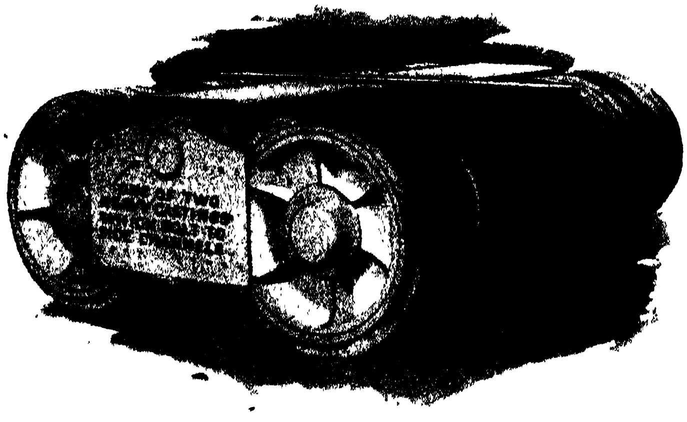
In order to move heavy machinery without crushing paved or surfaced roads, the equipment is placed on a trailer equipped with 16 solid rubber tires on wheels mounted on rocking axles

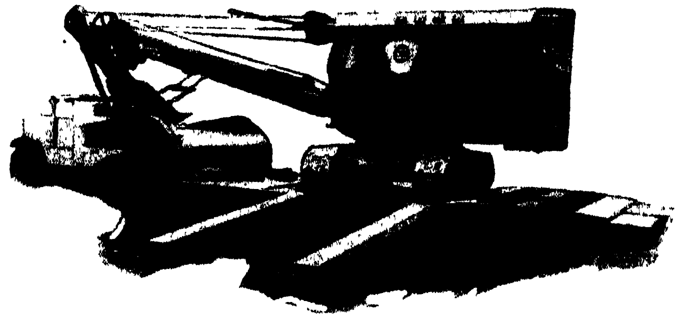
TO keep pace with the trend toward larger and heavier construction equipment, such as steam and electric shovels and draglines, trailers of a new type are now being used to transport such equipment. Laws to prohibit the movement of heavy equipment under its own power have been passed by a majority of municipalities, states, and counties. In order to prevent unnecessary damage to paved and surfaced roads, many highway authorities insist that large and heavy equipment must be moved on rubber-tired wheels. Even when using rubber tires, the street or road is likely to be damaged if the load is not equalized properly by the use of auxiliary wheels.

The trailer illustrated here has a capacity of 100 tons, and by means of eight double-rocking wheels, the load is equalized sufficiently to transport the heaviest equipment now in use without damaging the pavement or highway surface. Sixteen solid rubber tires are provided on eight wheels mounted on double rocking axles which automatically distribute the load over all of the tires in such a way that the wheels can conform to the variations in the surface of the road. This eight-wheel assembly is used on the rear of the truck where most of the weight is centered. The front part of the trailer is supported by a heavy duty "goose-neck" attachment, which facilitates hauling.

Each four-wheel rocking assembly functions as a complete unit, although pivoted on the heavy main shaft or axle. Between each pair of wheels is a rocking member composed of an electric-steel casting with bronze bushings, attached to a heavy steel shaft, which provides the flexibility needed when a wheel encounters a minor obstruction or depression in the road. Each wheel is mounted on a non-tapering spindle, equipped with tapered roller bearings. Extra large brake shoes are provided. The mechanical parts are all lubricated by grease gun, and every axle is so shaped as to provide a grease pocket or reservoir.

In the illustration at the top of the page, showing the rear section of a large-capacity trailer, the flexibility of the wheels is shown clearly, as one wheel passes over a depression in the road. The method of loading a large Diesel-electric shovel is shown in the picture immediately below that of the trailer. By means of heavy planks placed to form ramps, the shovel moves under its own power to take its place on the trailer. The powerful truck which provides the means of locomotion is dwarfed by its massive cargo.





At the left is shown a four wheel double rocking unit detached from the axle. Note the grease pocket on the main shaft. At the lower right, a wheel assembly is shown with two of the wheels removed. The outer bearing and nut have been replaced to illustrate their position when assembled. Control of the trailer is facilitated by the extra large brake bands. At the bottom of the page the detail of the eight wheel assembly is illustrated. Two heavy castings bolted to the side channel beams provide housings for the ends of the main shaft or axle. The trailer is suited to a wide variety of applications, depending upon the shape and nature of the equipment to be transported, the length of the haul and local factors.

¶ *When a graceful bridge serves as a new tie to aid in cementing existing bonds of friendship between two great countries, it takes on an economic significance aside from its engineering features. Such a bridge is the Ambassador Bridge from Detroit to Windsor, Canada, an article on which is coming soon.*

"Fingerprinting" Autos

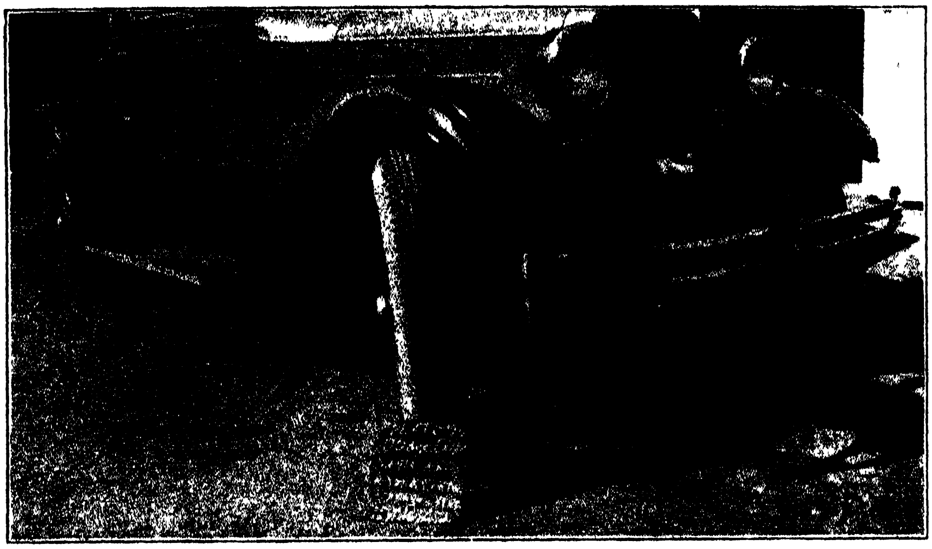
By means of an identification system recently perfected by Deputy Sheriff Dave Chapman of Los Angeles County, California, criminals and felons can be apprehended under certain circumstances by the imprint of their automobile tires. From a scientific study of the tire imprint and comparisons with marks on record in the Sheriff's office, it is possible to determine the make and size of the tire, which wheel it is on, and the approximate type, load, and speed of the suspected car at the time the felony was committed.

When suspicious-looking tire marks are discovered near the scene of a crime, a try-square is placed on the ground beside the marks and measurements and photographs are taken. This data is compared with office records of the 450 different kinds of tire-tread patterns now in use. After determining the make, size, and position of the suspected tire, officers watch for cars having the distinguishing tire or tires.

By means of the new system of identification, several professional chicken thieves were apprehended recently near Los Angeles. When confronted with the unexpected circumstantial evidence against them, the thieves confessed and were sentenced.

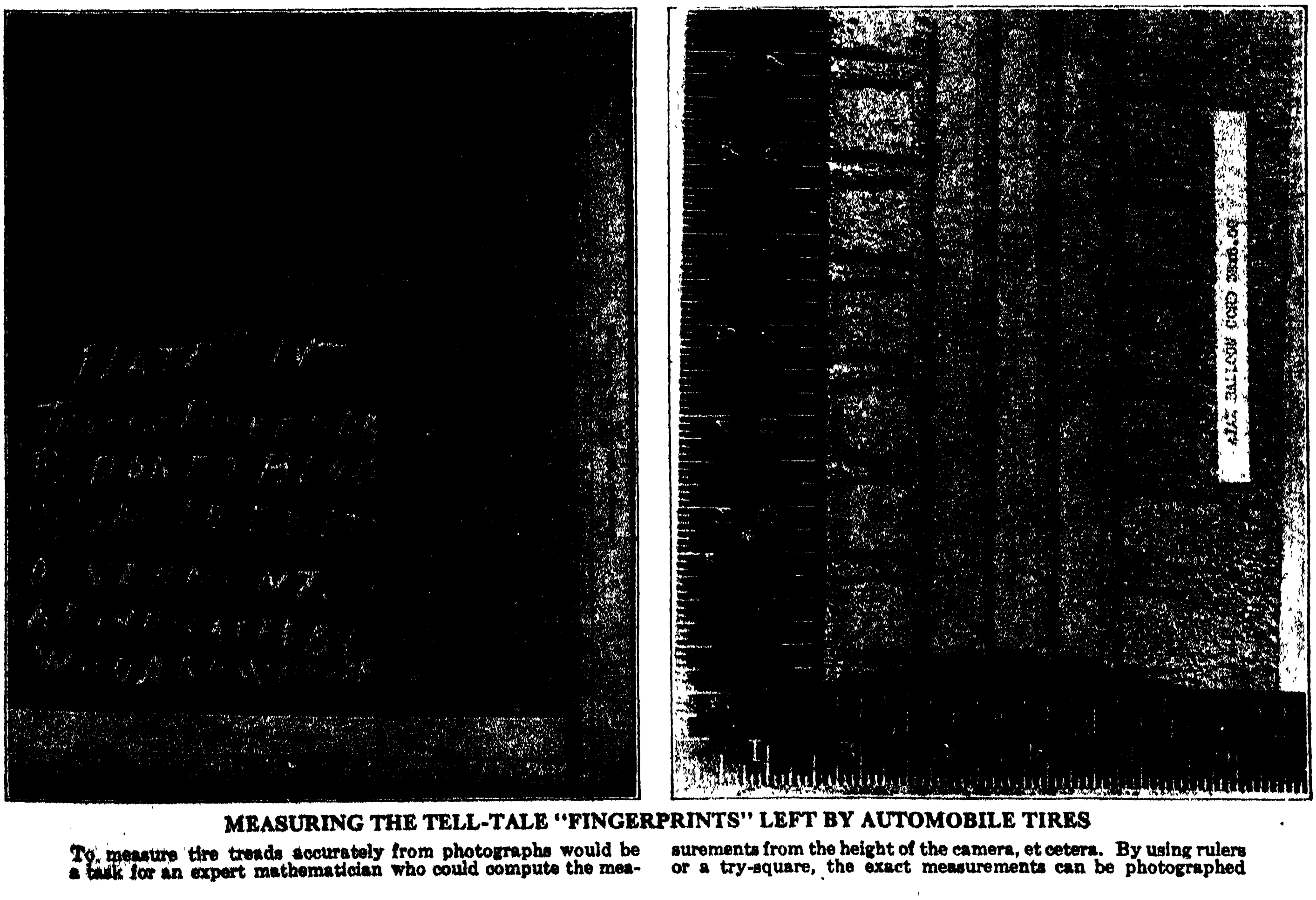
COMPARING TIRE PRINTS

Deputy Sheriff Chapman calculating similarities between imprints and blueprints



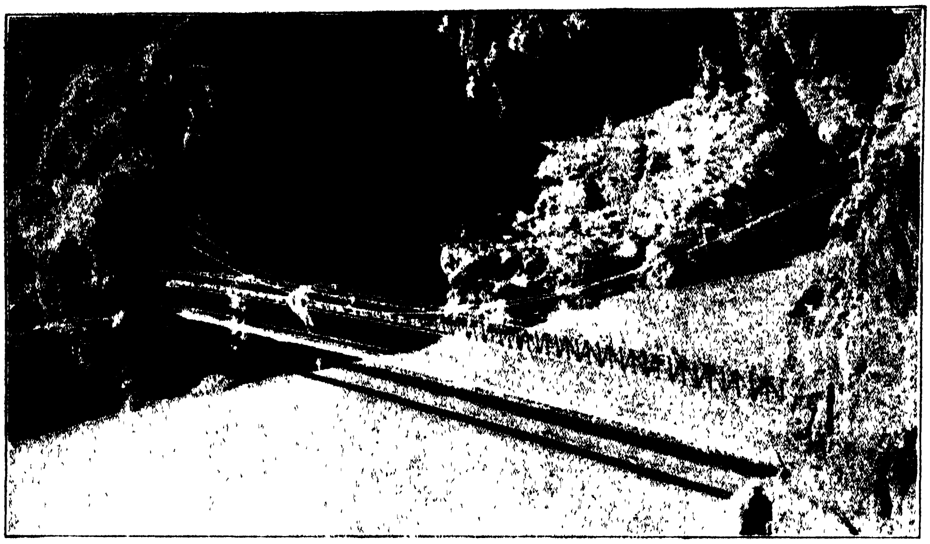
HELD FOR INVESTIGATION AS A SUSPICIOUS CHARACTER

Branded by the distinguishing tread mark of its right front tire, this car was apprehended by the authorities after it had participated in a long series of thefts in southern California



MEASURING THE TELL-TALE "FINGERPRINTS" LEFT BY AUTOMOBILE TIRES

To measure tire treads accurately from photographs would be a task for an expert mathematician who could compute the measurements from the height of the camera, et cetera. By using rulers or a try-square, the exact measurements can be photographed



SUSPENDED ON SLENDER THREADS

The tourist to the Grand Canyon may now take a train to the region, cross the new canyon bridge safely afoot or on horseback, and then proceed on his journey via another railroad

Bridging the Grand Canyon*

Intrepid Engineers Anchor Cobweb of Steel to Gorge's Precipitous Walls

By KIT McKENZIE

ACROSS the Grand Canyon of the Colorado, at the foot of the Bright Angel Trail, engineers of the National Park Service and Forest Service have spun a bright new cobweb of steel upon which the tourist may cross safely from the south rim to the north and the great Kaibab Plateau. Adventure and danger were the warp and the woof of its building; its opening last year represented a triumph of man over nature in the face of appalling obstacles.

Years ago, when men first crossed the canyon, they swung dizzily through the air on a single cable, high above jagged granite rocks and the swift and dangerous river. Later, the first straggling tourists crossed on a swaying suspension bridge, built by the National Park Service in 1920, the first span to be thrown across the chasm and the only safe means of transport in a stretch of 300 miles.

The need of a new bridge became apparent in 1927, when the Kaibab Trail was under construction, and funds from the Roads and Trails Fund of the Service were made available for its building. The old bridge had served its purpose well, but it was considered too light and too elastic to accommodate safely the increasing number of visitors to the Park. It swayed to the rhythm of the pack train, and winds driving up and down the canyon at a terrific rate tossed it about so violently at times that crossings were impossible. More than once during a violent storm it was turned completely over.

In designing the new bridge, unusual factors had to be considered. Not the least of these was the difficulty and expense entailed in transporting materials from the rim of the canyon to its floor, an airline distance of about four miles and a drop in elevation of nearly 5000 feet. The construction of a cableway was considered, but after careful study it was decided that a pack train would be more economical and satisfactory.

THUS down a narrow, zigzagging defile, seven and a half miles in length, sturdy little donkeys packed the bulk of the materials and supplies used in the construction of the bridge. Three months were required to carry the main part of the load from Yaki Point to the construction camp, pitched at the junction of the roaring Colorado River and Bright Angel Creek.

Use of the pack train placed a limit upon the size of the pieces used in the bridge and affected its design. Only pieces ten feet or less in length could be transported by the animals and the weight each could sustain was limited to 200 pounds. Each of the main cables, of which there were eight, was 550 feet long and weighed over a ton. These were carried down on the shoulders of 42 men, mostly Indians, each man supporting a weight of about 50 pounds. The wind cable came in one piece, 900 feet long, and was transported by means of "go-devil," or heavy sled of original design.

Drawing up the actual plans and specifications of the bridge presented peculiar difficulties. The distance to be spanned measured 500 feet between supports with an allowance of five feet for width, since a narrower bridge would be likely to interfere with the passage of a loaded animal and, if the bridge were wider, there would be more opportunity for the animals to turn around and cause confusion in the line of a pack train. In spite of these limitations, it had to be strong enough to carry a train of any length; that is, a string of animals completely covering it from end to end.

POSSIBLE congestion due to inexperienced riders had to be taken into account so that the structure would hold even in a stampede. It had to be rigid so that there would be no possibility of a swinging or jarring motion that would cause fear on the part of tourists. The rushing winds of the canyon had to be provided for; the bridge must remain staunch against transverse wind stresses that might cause it to turn over as the old one had done.

The new bridge is the longest ever built by the Park Service, the usual run being from 100 to 300 feet. Therefore the engineers, Chief Engineer F. A. Kittredge, Ward P. Webber, designing engineer of the Park Service, and John H. Lawrence, a Forest Service construction engineer, were called upon to exercise their inventive genius in meeting and solving the unusual problems encountered without incurring too great a cost.

The first items of construction were the pits for the main cable anchorages

A TICKLISH JOB

In a saddle suspended from a transverse cable, engineer Lawrence anchors a wind cable to the precipitous canyon wall

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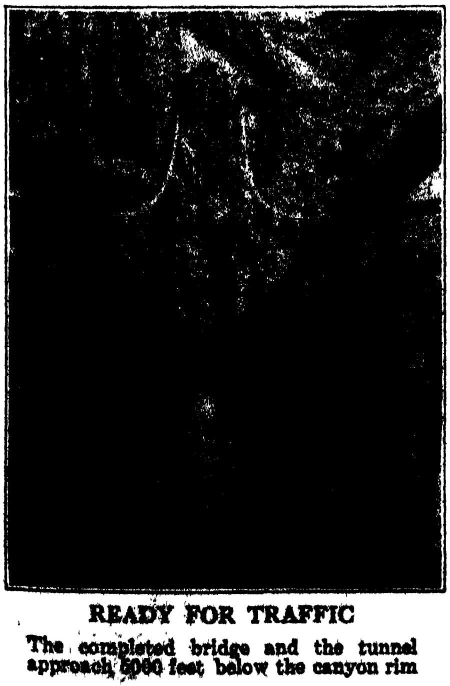
*Reprinted by permission from *American Forests and Forest Life*. Photographs courtesy Department of the Interior, National Park Service and cable supports. On the north end the upstream pit was sunk 14 feet into solid rose granite; the downstream pit was drilled four feet into the rock of the canyon wall.

Since the new bridge was to be located on the site of the old, but at a slightly higher elevation, and the old bridge was to be in uninterrupted use during construction of the new, all excavation work had to proceed cautiously for fear of dislodging the old supports. Only light blasts were possible and certain parts of the original bridge had to be braced to insure safety. The anchorage steels were deeply imbedded in solid concrete and farther down the canyon wall, concrete cable supports and the north abutment were constructed under conditions that were equally hazardous.

BECAUSE of the higher elevation of the new bridge, the trail approaches at both ends had to be altered. At the north end this was fairly simple. A spiral was constructed beginning at the grade of the old abutment, swinging upstream and to the east, then back to the new bridge. This permitted using part of the old trail and gave an easy, attractive approach to the new structure.

Excavation work was simultaneously under construction at the south end of the bridge and here more serious difficulties were encountered. First of all, the location of the new cable supports was so near the old that making open cuts in the rock for passage of the main cables would seriously endanger the security of the old bridge. To obviate this, small tunnels had to be drilled back to a safe mooring through the solid rock. The canyon wall in that place was of a mica schist formation—very blocky—and the concrete works of the old cable anchorage lay directly above each new cable tunnel. Consequently the tunnels had to be excavated by hand. They measured about two and a half feet in cross-section and were 17 and 11 feet long.



READY FOR TRAFFIC

The completed bridge and the tunnel approach 5000 feet below the canyon rim

Because of the overhanging canyon wall, creating a danger from falling rocks, and other factors, a tunnel had been decided upon as the safest approach to the bridge from the south. Its construction was an achievement in itself. It is 105 feet long, 10 feet high and six feet wide. Workmen doing the excavation were inadequately equipped with tools, two old air compressors being all that were available for work on the entire structure. Half the time these operated so poorly that both had to be used to run one small jack-hammer. To speed up construction, two eight-hour shifts of workmen operated in the tunnel day and night with the work in progress at both ends. The arduous nature of the task can be imagined from the report of Engineer Webber, a part of which follows:

"An average of seven hours was required to drill a round of seven holes," he wrote, "the eighth hour being required for loading and blasting. One round would 'pull' from two to four feet, depending on the material encountered. All tunnel workers had to wear respirators and goggles as a protection against rock dust, and owing to the extreme danger of some of the rock over the portal caving in, it was necessary to resort to timbering and, later, to concrete the portal."

THE hoisting of the main cables and their adjustment signaled the beginning of the bridge proper. When these had been secured, an engineer and a rigger swung out over them in fragile-looking swing seats called "bos'n" chairs to measure and mark them for the hanger cables. The transoms, each consisting of a floor beam and two verticals, were then trundled out onto the old bridge and attached to the hanger cables at positions corresponding to those they were to occupy in the new structure. Then the entire group was hoisted by means of a tackle and adjusted in place by a rigger.

The framework of the bridge having been spun, there remained the adjustment of the heavy floor beams. These were riveted together and swung directly onto the bridge by means of a special cable, or high-line, strung across the canyon above the new structure. Large and unwieldy, these beams were perhaps the most difficult parts of the bridge to place. The riggers had to "ride the steel" and make a flying connection. As fast as the sections were brought up and placed, the floor plates and guard angles were brought onto the bridge and bolted into their places. Then stiffening trusses were laid and riveted together in a continuous piece to give the greatest possible rigidity.

A PYTHON-LIKE CABLE

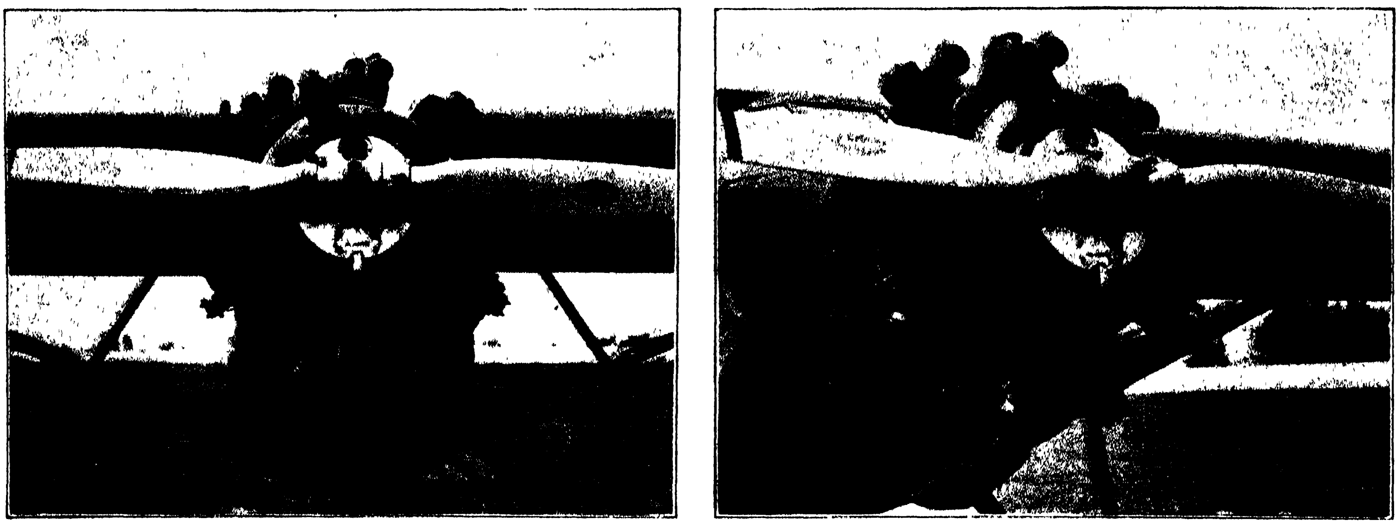
From the canyon rim down the Yaki Trail a cable is carried on men's shoulders

The next task was to adjust and anchor the cables designed to brace the bridge when swift storm winds ride the canyon. The anchorages of the wind cables, one on each side of the bridge, were placed at an angle of 26 degrees below the bridge so that the cables would brace it not only against transverse currents but also against winds tending to lift and toss the floor. Placing the anchorages in the sheer rock lining of the canyon was a task both dangerous and difficult. The jack-hammer operator who drilled for the guys was lowered by a rope over the precipitous wall and hung in a sling from two ropes, 125 feet below the rim of the canyon, with 70 feet of rock, in a sheer drop, below him to the river.

TO afford a more secure foothold on the bridge, a two-inch surfacing of screened gravel, sand, and cold asphalt emulsion was laid on the floor of the structure. Other finishing touches, such as the wire fence and guard rails on the sides of the bridge, were then added to complete the structure.

It is a tribute to the engineers that in building this great bridge across so awesome a chasm not a life was lost. Even the patient, plodding pack animals came through the ordeal safely. There are 122 tons of steel and other materials in the bridge; not one piece was dropped into the river far below.

¶ *"Will the business man fly?" is the subject of a coming article which points out many pertinent facts that tend to show the gradual but inevitable adoption of the airplane by business on a wide scale.*



TWO STRIKING VIEWS OF THE PACKARD DIESEL ENGINE FOR AIRPLANES

The Airplane Diesel in 1940

The Many Advantages of This Simple Power Plant Point Toward a Great Increase in Its Use

By ROSWELL H. WARD

Managing Editor, Motorship

IT is a far cry from the cumbersome stationary Diesel engines of past decades, deep-rooted in massive foundations and cumbrously wrought in cast iron, to the alloy-steel perfection of the present day airplane engine, eloquent of speed, power, and *light weight* in every line and contour!

However, it has been this technical gulf, this wilderness of abstruse metallurgy, combustion phenomena, and stress analysis which the Diesel engineer has had to bridge in essaying the development of a practical aviation Diesel engine.

HOW successful these explorations have been is evidenced by the remarkable evolution of light-weight, high-speed Diesels in recent years. In the 11 years since the World War, the weight of the lightest Diesel engine has been reduced from about 65 pounds per horsepower to less than three pounds per horsepower, and the speed, which in the past was supposed to be definitely limited in the Diesel engine, has been increased from about 750 revolutions per minute to well over 2500! And at least two types of Diesel engine—probably more—have actually flown in heavier-than-air machines, to say nothing of the Diesels installed in the British dirigible *R 101*, which, at the time of writing, has been successfully flown in various tests. (See photograph on page 38.)

Diesel aviation progress has reached a transitory stage, where its advocates, gratified at last to see a Diesel engine actually in flight, have inclined to over-enthusiasm in prophesying the scope of its immediate application.

The air transport executive, confronted with the necessity of making an impartial technical judgment, has reacted to this over-enthusiasm in a way well expressed in these columns heretofore, (See SCIENTIFIC AMERICAN for September, 1929), and has raised a series of very sound questions which deserve to be answered by careful analysis rather than by argumentative advocacy.

Foresight

THE question of Diesel engines for airplanes is one that is of absorbing interest to everyone following the progress of aeronautics. The accompanying article was prepared to supplement the one entitled "Is the Airplane Diesel Practical?" presented in our issue for September 1929, and in doing so, the author placed the time of his description ten years in the future. But this is no "futuristic" story based on a vivid imagination. It is a straight-forward presentation of facts that are apparent to all those with eyes to see, amplified by a thorough knowledge of the subject gained through close association with the men in the Diesel field who have been doing things.

—The Editor.

No one should be more cognizant of the scope and limitations of the aviation Diesel engine than the Diesel engineer. The basic problems in the construction of high-speed Diesels have been solved, but a tremendous amount of detailed development work must still be done to insure the future of the airplane Diesel.

There are metallurgical, production, and theoretical design problems to solve. In its present form the aviation Diesel can undoubtedly become in a few years an important *supplement* to the airplane gasoline engine, especially in large airplanes and seaplanes and in dirigible balloons.

Further to present a graphic picture of exactly how the aviation Diesel compares in actual flight with the gasoline engine, we will be over-conservative and estimate a lapse of 10 years, from which point of time we will visualize the attainment of the widespread use of airplane Diesels. Engines such as these will undoubtedly be in extensive use long before 1940, but we will jump ahead a decade in our prophetic study in order to depict the perfection of development which will probably be realized long before that time.

ANY airplane—whether large or small—is subjected to a daily inspection, a careful grooming and scrutiny which has in its routine attention to detail few parallels in any field of engineering or transportation. Skilled mechanics go over the engine, riggers examine the wings and control surfaces, keen-eyed inspectors check their reports and repair work with great care, and finally, the operations executive carefully scrutinizes the reports of both ground engineers and pilots. A race horse or a fine motor car gets no more attention on the eve of a great contest than does a transport airplane in the course of everyday service.

Let us follow the inspection of a 1940 Diesel "motorship of the air" such as we foresee, and determine wherein it differs from the present rites of those who serve the gasoline driven airliners. As the cowling is removed from one of the six-cylinder "in-line" air-cooled Diesels, (a cowling which leaves the upper part of the cylinders exposed and directs the air stream along the cooling fins), our attention is drawn to its extreme simplicity.

There is no carburetor or intake manifold; there is no electrical ignition, no magneto or spark plugs; there is only a small pipe to the head of each cylinder, and there is only one valve in each cylinder head, from which a small "exhaust deflector" projects.

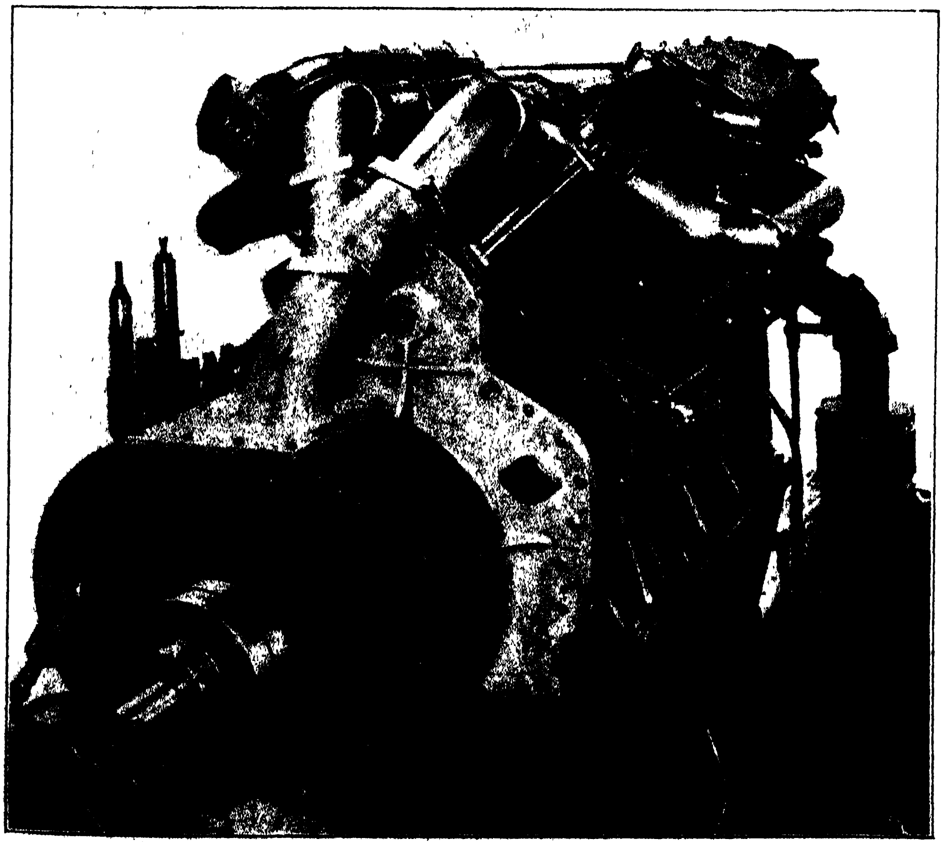
THE ground engineer does not have to adjust the carburetor; he does not have to worry about the intricacies of electric ignition or fouled spark plugs; when there are valves to be ground, there is just one, which takes care of both the air intake and exhaust in each cylinder.

The engineer is dealing with the highest expression of man's battle to wrest heat energy from petroleum—the most efficient heat engine in existence—and mechanically by far the simplest. With a compression about twice that of the ordinary aviation gasoline engine, this Diesel draws in the outside air through the single valve in the head, compresses this air to a temperature sufficient to ignite the charge of fuel-oil sprayed in from a little nozzle in the top of the cylinder, and when the power stroke is complete, exhausts the spent charge through the same valve in the cylinder head.

(This description is for a "four-stroke-cycle" engine; there will be numerous other types using the "two-stroke-cycle" and highly original valve and structural arrangements, but for descriptive purposes this type of engine has been selected as representative of American practice as now foreseen.)

Spared carburetor and magneto work, and with his valve inspection reduced to half, our mechanician, however, is up against some purely Diesel problems. He will have to remove and inspect the fuel nozzles in each cylinder head and, while the engine is running, will have to assure himself that the fuel pump which supplies a minute quantity of oil to each cylinder is functioning properly in its split-second work of metering and pumping.

THIS fuel pump is one of the points often criticized by those who question the reliability of the Diesel. It is the perfect embodiment of precision workmanship, is ground and honed so that its plungers fit to extremely close limits. This, in theory, is a knotty production problem. However, in actual practice, certain well-designed types of fuel pumps have shown themselves to be almost fool-proof. The precision of construction and the number of working parts in a well-designed Diesel fuel pump are much less a problem, comparatively speaking, than that of producing electric ignition magnetos and distributors, intricate operations which are taken for granted today.


THE STEARNS DIESEL ENGINE

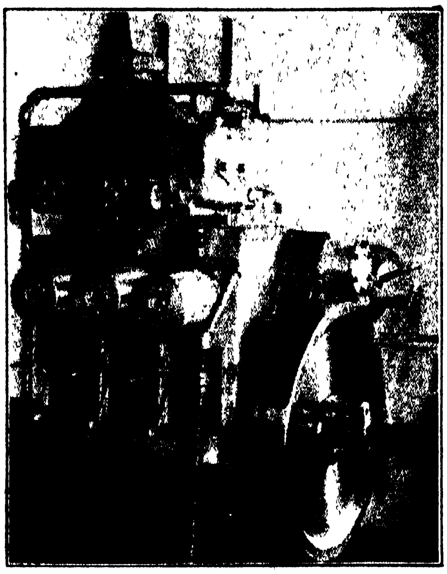
DESIGNER AND PILOT

Left: Capt. L. M. Woolson, designer of the Packard Diesel, and Walter Lees, pilot

Most American difficulties with experimental fuel pumps have, to speak bluntly, been due to poor design, or to poor production engineering. As the demand for this type of equipment increases, this problem will be overcome, as many other more intricate ones have been solved.

WE mentioned above that our mechanic was working on an engine with *twice* the compression of a gasoline engine. This presents another difficulty—that of starting. At present an electrical starter capable of turning over a Diesel engine is much too big and heavy for airplane use. However, we may expect that this trouble will be mastered by releasing the compression in several cylinders and using an electric starter, or by some other expedient—it even having been whispered that a small gunpowder cartridge is used for starting on one American aviation Diesel!

Now that the inspection of our "air motorship's" power plant is completed, here comes a tank truck with fuel for it. To one reared in the atmosphere of high-test aviation gasoline, volatile benzol compounds, and so forth, the calm superiority of the "grease neck" who smokes a cigarette as he pushes the hose into the oil tank is somewhat uncanny; but he is dealing with fuel oil of about the consistency of ordinary furnace oil—non-volatile and unaffected in its condition in the fuel tank



Courtesy American Machine and Foundry Co.

MOREN-BRONANDER DIESEL

Estimated horsepower of this engine, at 1200 revolutions per minute, is about 30

by changes of altitude—it will not produce inflammable vapors in a rarefied atmosphere, or on the ground.

This new generation of "Diesel bred" airplane mechanics commit another heresy in the eyes of the old timer: they start the engine while the fueling operation is going on! But the exhaust from the cylinders is clear and carries no flame—and the ignition point of the fuel oil is so high that one could even spill some of it on the engine and it would not actually burn—something to be thought of in the event of a crash, and certainly a condition which makes for greater ease, safety, and time-saving in servicing the plane.

The scarcity and possibility of contamination of fuel oil at airports around the country is also one of the criticisms of the aviation Diesel. But what can one expect? Just as American industry will build reliable fuel pumps in quantity and develop workable methods of starting, so will the oil industry respond with more easily available supplies of Diesel fuel. Long flights have already been made on ordinary furnace oil and oil of that type is almost as easy to get as gasoline in this day of household and industrial oil burners!

IT was not necessary for the mechanic to start the engine to "warm it up," as is done now with all gasoline aircraft engines. All aircraft Diesels are "cold starting," the heat of the first compression is enough to ignite the fuel, and a Diesel airplane can take off immediately the engine begins to turn over, although if not necessary, it is just as well to let it "tick-over" on the ground for a short time. However, in cold weather operation, in an emergency, or in military service, this characteristic is something to be considered.

Now that we have entered the cabin and have waved farewell to those who watch our pilot "lift" us off the field with the calm mastery of these picked men who handle transport aircraft, we notice a smoothness of flight and an absence of that vibration which is sometimes felt in airplanes. This elimination of vibration is due to the fact that the engine does not run as fast as a gasoline engine. In order to get the weight of gasoline engines down to their present basis, it has been necessary to increase the power by increasing the speed, usually to 1800 or up to 2200 revolutions per minute. The Diesel will operate normally at about 1200 revolutions per minute, which is a much more efficient propeller speed then the higher figures mentioned.

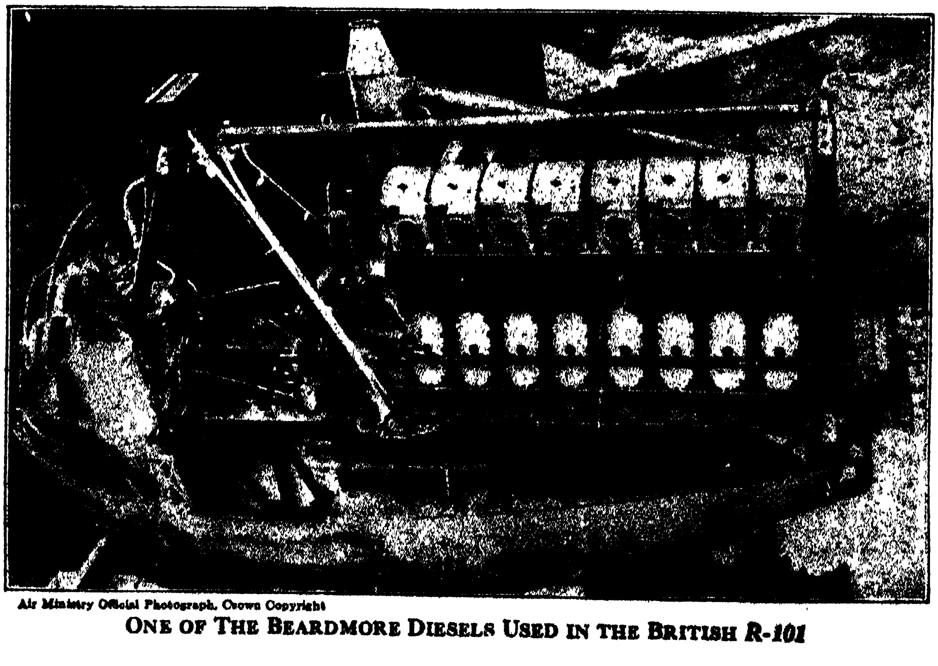
We may smoke in our cabin, just as the service man did and for the same reason, and our guide points out to us that spilling of the fuel, in event of a forced landing, would not set the plane on fire. A comforting thought for those with lively imaginations!

AND another characteristic is pointed out: Due to the fact that the fuel does not form a volatile mixture until it enters the cylinder, there is no chance of a backfire into the intake manifold as sometimes happens with gasoline engines. And the position of the airplane exerts no effect on the fuel supply; the fuel pump and the fuel nozzles will work as well upside down as they will in the upright position.

We look over a report on the cost of operating these Diesel-engined airplanes. The engine costs more than a gasoline engine, and will until quantity production is achieved. The fuel cost is considerably less than that of a gasoline engine. We are using Diesel fuel at about six cents a gallon instead of high-test gas at from 14 to 25 cents. But this is not the main argument for the economy of the Diesel. For a given combined weight of fuel supply and engine—provided that the weight of the Diesel engine is somewhere near that of the gasoline engine, (on this point more will be said)—the flying range or the carrying capacity of the Diesel-engined airplane is greater than that of the airplane with a gasoline engine. This is especially true for flights of 500 miles and over, when fuel economy becomes a large factor. Estimated conservatively, given the conditions outlined above in flights of this type, the cruising radius, or the weight-carrying capacity of the Diesel-engined airplane would be from 20 percent to 30 percent greater than that of an airplane powered with a conventional type of air-cooled gasoline engine, such as we know today.

THE condition made above in regard to weight is the prime reason we have conservatively set the date of the general use of aviation Diesels some years ahead. The aviation Diesel is now considerably heavier than gasoline engines—and this increased weight offsets most of its other advantages. However, as the weight is reduced, the fuel economy will help to make up for what weight handicap is left, and the Diesel will first become an important *supplementary* form of power to be used in large aircraft for long flights.

It is difficult to foresee what would happen if a Diesel were produced as light as the present types of air-cooled gasoline engines, but in view of the high degree of refinement of gasoline airplane engines, it is hardly likely that the Diesel will ever entirely replace them. However, it will assume a position of ever-increasing importance in those services where long range reliability, weight-carrying capacity, mechanical simplicity, and super-safety are desired.



Air Ministry Official Photograph, Crown Copyright

ONE OF THE BEARDMORE DIESELS USED IN THE BRITISH *R-101*

Sea-Safety Contest Winners

Our Competition Has Focused Attention on Devices That Make for Safe Navigation, and Are Reliable in Emergencies

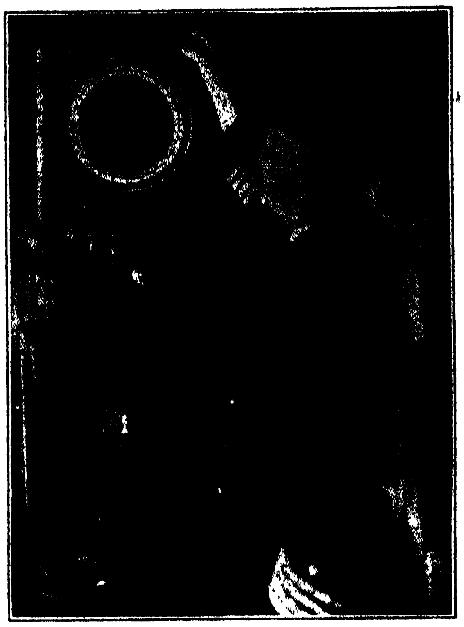
By ALBERT A. HOPKINS
Secretary of the Committee of Award

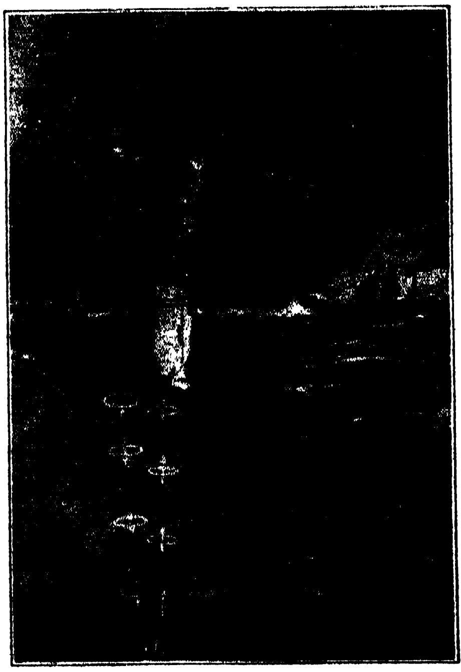
THE ninth SCIENTIFIC AMERICAN Gold Medal awarded by the American Museum of Safety was presented at a luncheon given by Mr. Arthur Williams, President of the Museum, at the Union League Club, New York, on November 7th. In the absence of Professor Fessenden in Bermuda, on account of severe illness, his son, Mr. R. K. Fessenden, received the medal and the citation signed by the members of the Committee, and responded for the winner. Mr. H. J. Fay, a business associate, read an admirable account of three inventions on which the citation was largely made. Those receiving the engrossed Certificates of Honorable Mention responded as each received the framed certificate.

THE task of the Committee of Award was to analyze the 80 designs or ideas: first to see if they conformed to the conditions; and second properly to evaluate their merit. The Committee was of highly technical structure, largely composed of men who are used to commanding vessels or fleets, and their decision may be regarded as of great technical value. Out of the 80 designs, 13 were selected for intensive examination; these were narrowed down to five, and then to one.

The Committee finally decided unanimously that the achievements of Professor Reginald A. Fessenden were sufficiently outstanding to warrant giving him the medal for his various devices for safety at sea. The award was made not for any one of his inventions but rather for a composite of them. Quite a formidable list of inventions was submitted and he then modestly narrowed it down to 12, as follows: The fathometer, acoustic-radio distance finder, phase compensator, iceberg detector, wireless direction finder (using the loop antenna), wireless compass (rotating and beam), gyro-compass and improvements, Fessenden prism, interference beam of radiation, submarine oscillator, wireless telephone, heterodyne.

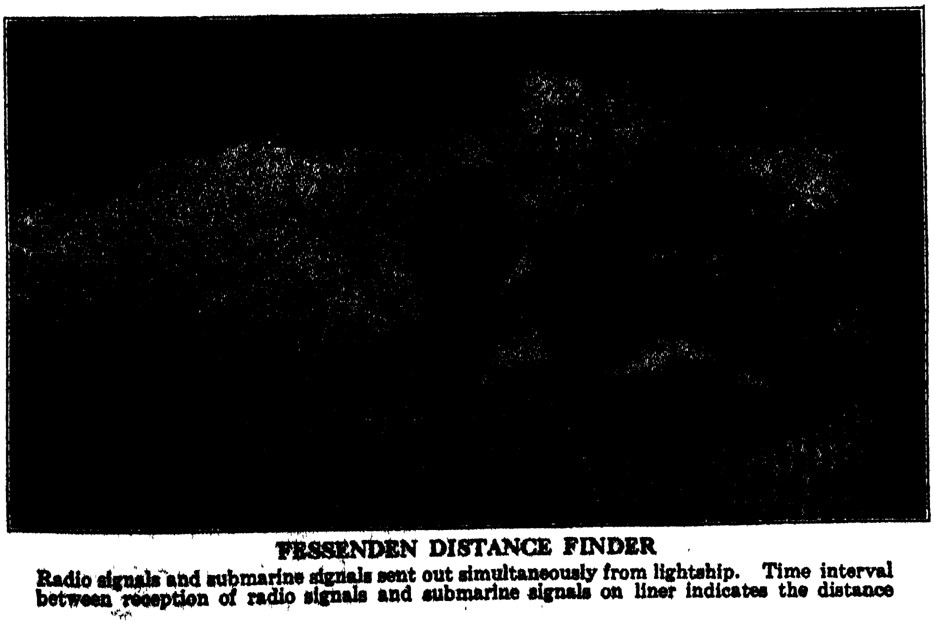
Professor Fessenden joined the Submarine Signal Company in the year 1912, and at once his great inventive genius was directed toward the development of better means of transmitting sound signals for communication through the water, with results that have been of great benefit to humanity.





FESSENDEN FATHOMETER

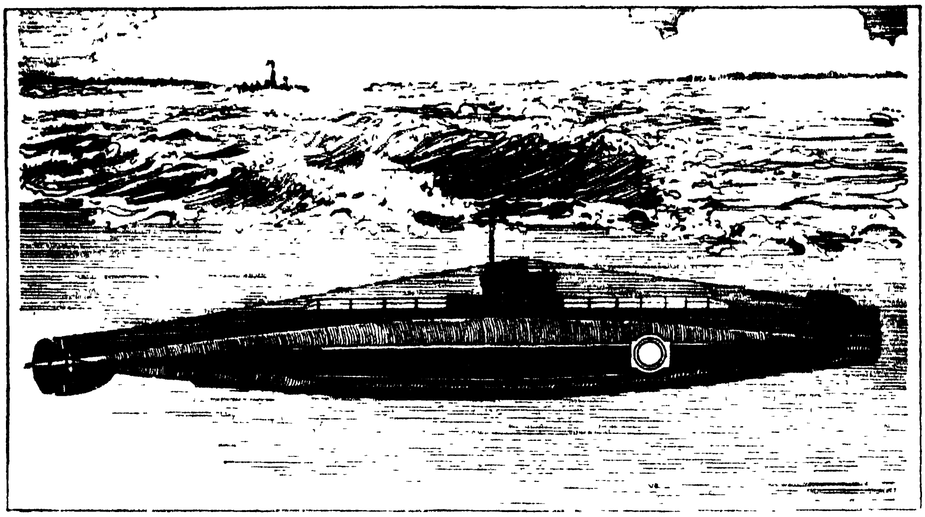
The fathometer is an electrical echo depth-sounding device which enables vessels to avoid stranding by ascertaining the depth between keel of the vessel and sea bottom without stopping the ship

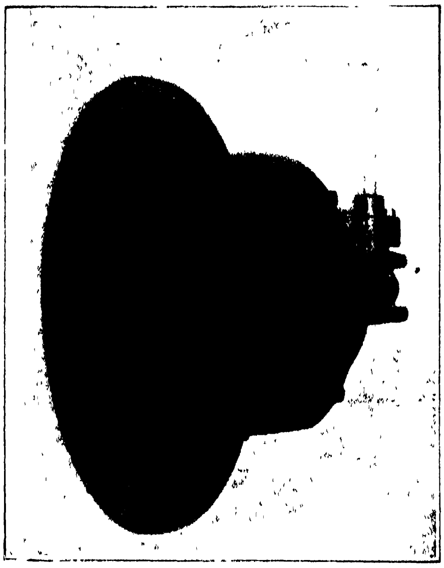


FESSENDEN DISTANCE FINDER

Radio signals and submarine signals sent out simultaneously from lightship. Time interval between reception of radio signals and submarine signals on liner indicates the distance

The perfection of the oscillator the following year revolutionized the art of submarine signaling, doubling and trebling the range at which it had been possible to send sound signals through the water. The ease and speed at which sound signals in the form of dots and





FESSENDEN OSCILLATOR

The oscillator sends dots and dashes through the water with ease and speed, doubling and trebling the range. Nearly every submarine in the world is equipped with this instrument illustrated at right

dashes could be sent through the water with the oscillator marked a tremendous advance over the older slow method of submarine signaling by a series of dots with a bell. The Navy, quick to recognize the value of the oscillator, adopted it for use on battleships and submarines. Today, practically every submarine in the world is equipped with one of these instruments.

Echo depth sounding, as embodied in the fathometer, marks the next and greatest work. This new method of depth sounding is linked in its history with the *Titanic* disaster. It was this appalling tragedy which led to experimenting with the submarine oscillator for the purpose of detecting the presence and proximity of icebergs, by means of an echo.

IN the winter of 1914, Professor Fessenden made tests on the Revenue Cutter *Miami*, while the latter was on its ice patrol off the Grand Banks. In these tests it was found that the oscillator could be used not only to detect the presence of and the nearness of icebergs but also to determine the depth of water beneath the revenue cutter by measuring the time between the emission of an oscillator signal and its return as an echo.

The submarine fathometer sends sound impulses periodically to the bottom of the sea, where they are reflected upward and then excite an electric sound receiver. The latter, by means of an electrical mechanism and a beam of light, indicates continuously on the calibrated dial the depth of water beneath the vessel.

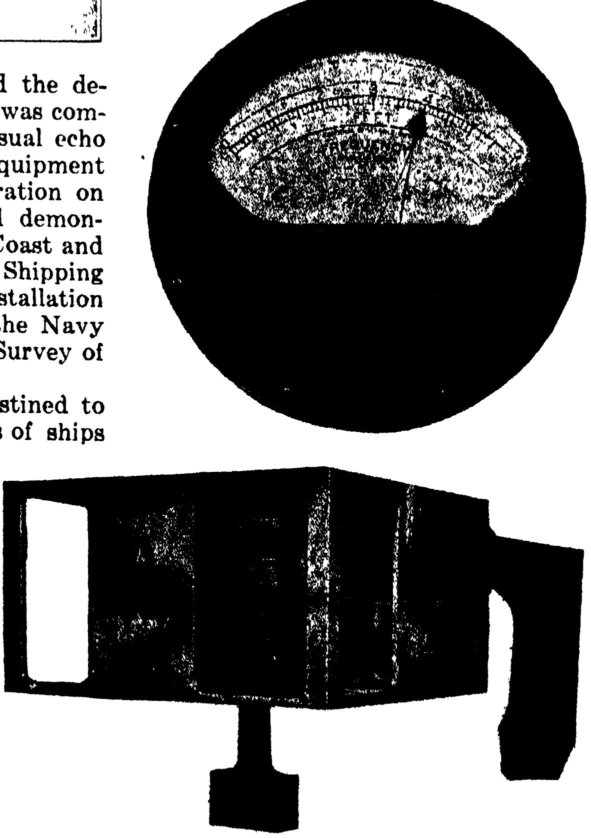
Because of the World War, work on the fathometer was delayed on account of activities in the development of submarine detection devices for the protection of shipping from the ravages of submarine warfare. After the war, the echo depth-sounding work was again taken up actively and the development of the fathometer was completed. In 1924 the first visual echo depth-sounding fathometer equipment was placed in practical operation on the steamship *Berkshire* and demonstrated to the Navy, to the Coast and Geodetic Survey, and to the Shipping Board. Following this installation came the approval of both the Navy and the Coast and Geodetic Survey of its accuracy and reliability.

That the fathometer is destined to save countless lives, hundreds of ships and millions of dollars seems unquestionable. The recent Safety of Life at Sea Conference at London has recognized this in recommending that the contracting governments should encourage the development and use of echo depth-sounding apparatus.

After the award of the SCIENTIFIC AMERICAN Medal the Committee considered that three devices were so outstanding in merit that a "Certificate of Honorable Mention" should be given. These honors are given to three individuals, two in New York and one in Utrecht, Holland, without designation of relative merit. Mr. J. Lyell Wilson of the American Bureau of Shipping, Member of the Society of Naval Architects and Marine Engineers, and the American Institute of Electrical Engineers, was given an "Honorable Mention" for his stability meter.

THE stability meter was designed to provide a ready means for determining the amount of stability or metacentric height that the vessel has while at sea on a voyage, so that water ballast may be used when needed to correct an insufficiently stable condition by lowering the ship's center of gravity. This use of water ballast has always been available but the means for determining when to use it has not, except by prior estimates of inaccurate and sometimes doubtful value, because of the infinite variety of possible service conditions.

In order to measure the stability of a floating vessel it is necessary to have some fixed axis for reference to which known forces and their effects on the ship may be referred. This part of the solution, which requires elaborate preparation, calm water, and the absence of wind and all other extraneous forces, is merely to locate the ship's center of gravity when she is empty. In principle it is exactly like finding the center of any irregular figure by suspending

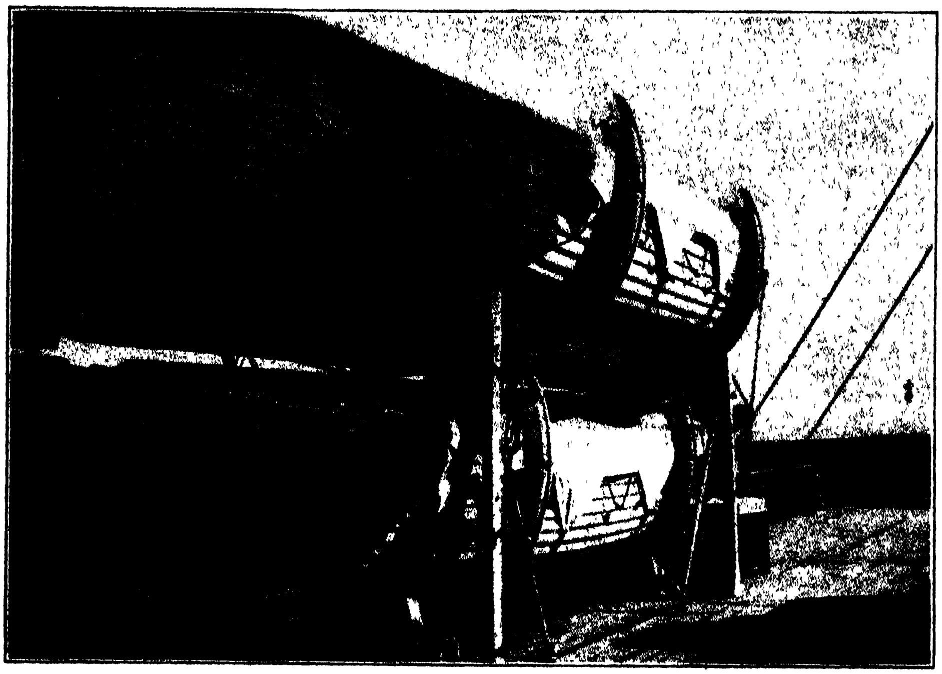


WILSON STABILITY METER

An accurate means for determining the amount of stability a vessel has while at sea, so that she can be ballasted. It utilizes a gyroscope and a pendulum it from various points together with a plumb bob so that the intersection of all the traces of the plumb line will be the center of area or gravity. From such a procedure, called the inclining experiment, and with mathematical analyses based on the vessel's form and loading arrangements, her stability for various conditions may be analyzed.

A much more accurate and convenient method of determining stability is available, however, in the use of the stability meter which ignores the statical condition in calm water but measures the dynamics during rolling, the reference axis being that of a gyroscope which is independently referred to a fixed axis in space.

The stability meter therefore comprises a gyroscope and a pendulum, each properly suspended in a frame fixed in the ship and actuating variable inductances, the component values of which are electrically integrated to give a resultant reading of metacentric height by means of a pointer traversing a dial similar to an ordinary voltmeter. Thus the action electrically is similar to the tuning of a radio set having two dials except that a variable voltage is produced instead of a variable frequency.



SCHAT SEA SKATE

A demountable attachment for life boats which facilitates their launching even with a forty-six-degree list. In launching, it skids the life boat over obstructions

Another "Honorable Mention" went to Mr. A. P. Schat of Utrecht, Holland, who made an unusual effort to secure the medal, even going so far as to make his presentment in the form of large beautifully illustrated pamphlets in the English language. Mr. Schat's device is called a "sea skate" and is an attachment to a life boat which enables it to be launched even with a 46-degree list. The "skate" skids the life boat over plates, bulges, and blisters, and once the water is reached it can be unfastened and sunk.

Mr. Jesse W. Reno of New York, a consulting engineer, received a "Certificate of Honorable Mention" for his life raft or live-saving net. His device consists of an extremely light raft or net made of balsa wood, the individual floats of which are joined by flexible connections, so that the net may easily be folded into a compact space for storage aboard the ship. When people are in the net in a rough sea, the lightness of the floats prevents injury when they are thrown against them by the sea, and the flexibility of the connections permits the floats to yield so that injury is prevented. Our illustrations give an idea of the device which is cheap, takes up little room, and has much to commend it in place of the ordinary life raft and the life preserver. Mr. Reno has devised a process for waterproofing the balsa wood so that its buoyancy is not impaired by becoming waterlogged.

RENO LIFE RAFT OR NET

This life raft or net is made of water-proofed balsa wood. The floats are flexibly connected, giving freedom from injury. The device takes up little room and is very light

The competition has served a useful purpose in focusing attention on these eminently practical inventions which are in being and which can be applied on any ship.

The Rarest Metal Yet Obtained

A Scientific Account of Research on Protactinium, Element 91, Which Is as Radioactive as Radium

By ARISTID V. GROSSE, Dr.Eng. (Chem.)
Director of the Chemical Research Institute, Shanghai, China

PROTACTINIUM, recently isolated by the writer, is a new, strongly radioactive chemical element. It is a metal like radium, but about two times rarer than the latter and, in fact, the rarest metal yet obtained in the world.

Of the great number of radio-active elements found since the splendid discovery of radium and radioactivity by Madame Curie in 1898, protactinium is the only one besides radium which can be obtained in larger amounts. Whereas the other radioactive elements are so extremely rare that most of them can not be seen even under a microscope, protactinium can be obtained in sufficient quantities to be investigated by the chemist in the same way as the common elements.

THE protactinium atom explodes in the same manner and practically just as violently as radium. While the average life of the radium atom is 2500 years, protactinium lasts about twenty times longer; that is, about 50,000 years.

During the explosion of the protactinium atom the alpha particles (helium atoms), electrons and gamma rays are shot off at enormous speeds. An atom of the element actinium is thus formed and it is from this property that protactinium derives its name (*proto*, meaning in Greek "first"). In addition to actinium a whole series of atomic disintegration products is formed, among which is the gas actinium emanation.

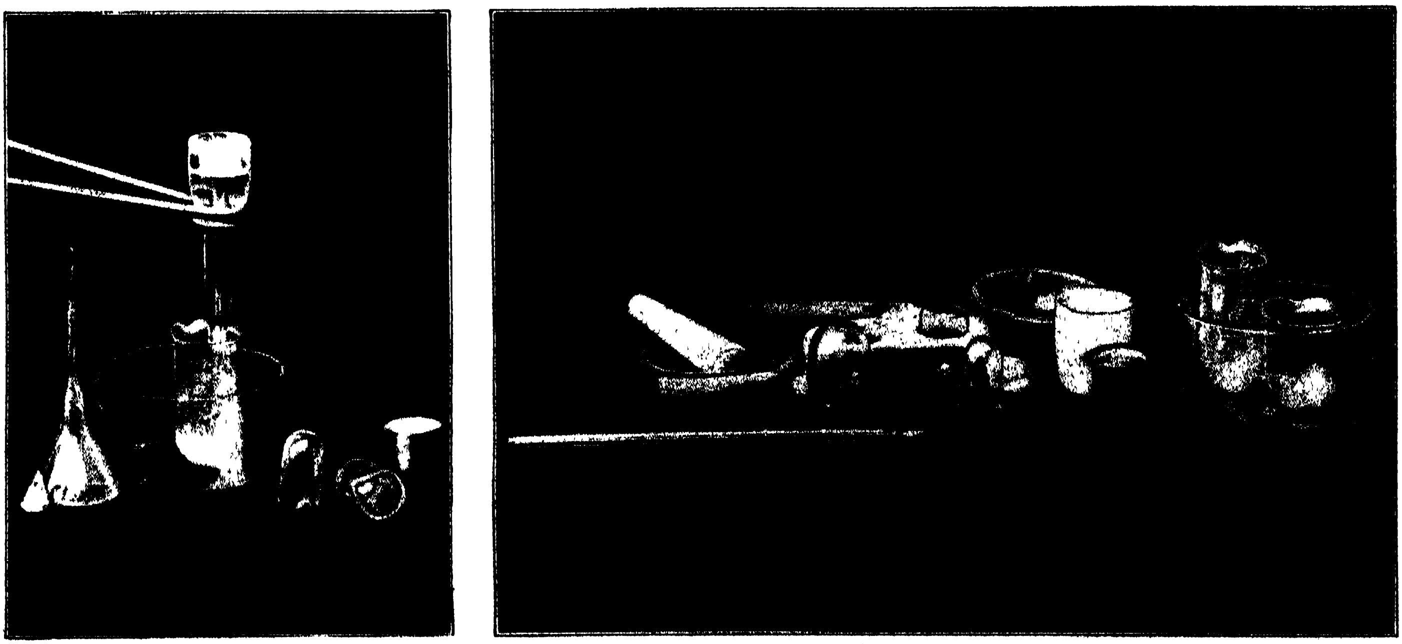
Chemically, protactinium is Element 91, called also "ekatantalum," occupying the ninety-first place in the periodic chart of the elements, between the two heaviest metals known, thorium and uranium.

FROM the text of the accompanying article, which was sent the editor from Shanghai, it is difficult to judge whether the author intends to claim the isolation of the pure element protactinium, as stated in the opening paragraph, or of the oxide as mentioned later. Apparently he refers to the latter. In any case his scientific feat is noteworthy. One American authority to whom the article was sent states his opinion that if protactinium comes on the market as a substitute for radium he does not believe the market price will reflect the fact that it can be produced more cheaply than radium but rather the fact that it is rarer. That is, the price would probably be higher than that of radium. This, of course, is put forth as nothing more than an opinion. —*The Editor*

The existence of Element 91 was foretold 60 years ago by the famous Russian scientist D. I. Mendeléeff, when he devised the periodic table of the elements. It was established as a fact in 1917 when Prof. O. Hahn and Prof. L. Meitner in Germany, and simultaneously Frederick Soddy, the distinguished pioneer of radioactivity working in England in collaboration with J. A. Cranston, discovered new alpha rays and proved that they came from a new element which could only be the Element 91, present in great dilution in their material.

DURING the following 10 years all efforts to obtain and isolate the extremely rare protactinium were unsuccessful, owing to the wrong chemical properties being attributed to it, and until 1927 nobody actually saw it. It was generally thought that Element 91 resembled tantalum, just as radium resembles barium; since the latter are always associated, an attempt was made to isolate protactinium by adding tantalum to the raw material and extracting them together.

In November 1926 the writer proposed a new theory of the chemical properties of Element 91, pointing out its difference from tantalum. In the spring of 1927 he had the good fortune of obtaining and seeing for the first time protactinium in the form of its



THE LABORATORY EQUIPMENT

At the left is the filtering apparatus and at the right the crystallizing equipment. As reproduced here each piece is seven eighths actual size, the "doll-house" sizes resulting from the minute, almost microscopic, quantities of materials involved in the work of research

COMPARISON of the PHYSICAL PROPERTIES of

PROTACTINIUM and RADIUM.

Properties.	Protactinium.	Radium.
Alpha rays:		
Range in centimeters at 15°C.	3.673	3.389
Velocity in kilometers per second.	15,500	15,100
Energy in volts.	2,340,000	2,365,000
Beta rays:		
Maximum energy in volts	318,200	185,000
Gamma rays:		
Wave length of the most penetrating ray in 10^{-11} cm.	38.2	66.0
Maximum energy in volts.	323,000	187,000
Average life of atom in years.	46,000	2,500
Price per gram in dollars.	? ?	65,000

HOW PROTACTINIUM DIFFERS FROM RADIUM

The use of the word "rays," although common, often misleads the layman. Alpha and beta rays are really particles rather than waves such as the gamma rays are. The latter differ from visible light only in wavelength and occur in the ether of space, like radio waves

pure white oxide, as shown in the illustration. The oxide forms an absolutely white powder with a very high melting point. It shines with a faint glow in the dark, due to the explosions in the atoms.

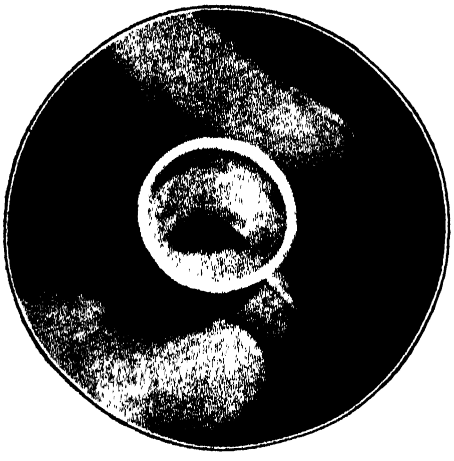
The difference from tantalum, previously predicted, was therefore established as a fact. It was not even necessary to try the separation of protactinium from tantalum, as it occurred by itself.

In 1927 only two milligrams of protactinium were obtained—just about as much as a needle point. As it was necessary to experiment for weeks with the same scarcely visible material, special equipment was devised to analyze, determine the radioactivity, filter, and crystallize minute quantities of matter. In the photographs, as reproduced, the original apparatus used is shown seven eighths natural size.

Very great care had to be taken during the work in order not to lose the extremely valuable material. Once one of the tiny beakers containing the whole available amount of protactinium slipped out of the writer's fingers and only by a lucky chance was an irreparable loss avoided. The experiments were accomplished during the author's stay in Germany, at the splendidly equipped Kaiser Wilhelm Institute of Chemistry, in Berlin.

In nature protactinium always accompanies radium in uranium minerals and ores. These contain for each gram of radium about 0.6 grams of protactinium. As has already been pointed out, Element 91 is the rarest metal obtained in the world, leaving far behind such rare elements as rhenium, discovered in 1925 by W. and I. Noddack and O. Berg in Germany, and illinium, discovered in 1926 by B. S. Hopkins, L. F. Yntema, and J. A. Harris of the University of Illinois.

In the richest uranium minerals Element 91 is found in the fantastic proportion of only 1 part to 10,000,000 parts of ore. It is therefore necessary to work up tons of raw material to get only grams of the new element. A special procedure is employed to detect the presence of Element 91; it is now possible to determine the amount of protactinium with great accuracy even in a dilution of 1 to 2,000,000,000, thanks to special analytical methods worked out at the Shanghai Institute.



FIRST RESULTS

Tiny crucible with first protactinium ever obtained. Note white oxide powder

While the uranium ore is worked up for radium, the Element 91 accumulates in the insoluble residues which constitute the wastes from radium factories and which previously had no commercial value. These waste residues contain protactinium in a much greater proportion than the natural uranium material, and therefore they represent at present the best raw material for the production of the new element.

One gram of radium now costs 65,000 dollars and, since Element 91 is rarer, one would think that its production cost would be higher. Yet protactinium would not be nearly so expensive as radium because the radium wastes are cheap, because their protactinium content is higher than that of radium in uranium ore, and because the protactinium extraction process is fairly simple.

For further research on protactinium larger quantities than the two milligrams obtained in 1927 were needed, and in 1928 radium wastes could be worked up in an industrial scale, thanks to the great German "dye trust" (*I. G. Farbenindustrie A. G.*). From half a ton of wastes from the old radium factory in Joachimsthal, Bohemia, which was presented by the government of Czechoslovakia, about 40 milligrams, or one hundredth of an ounce, of protactinium were extracted, under the supervision of the writer, at one of the *I. G. Farbenindustrie's* factories at Ludwigshafen on the Rhine.

The protactinium extraction process is fairly simple—much simpler than the production of radium. This is due to the individual chemical properties of Element 91, which differ very much from any known element. Radium, on the other hand, greatly resembles barium, so that it is difficult to separate the one from the other.

The wastes from radium factories

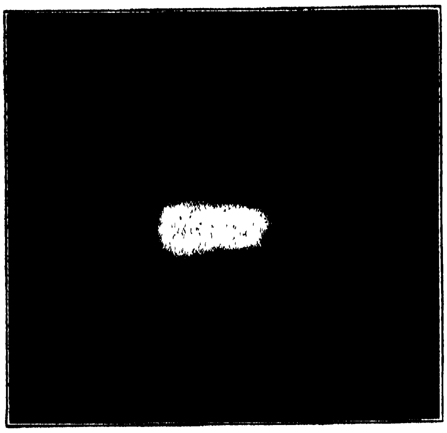
PERIODIC TABLE OF THE ELEMENTS
(lower right hand corner)
showing the position of the new element .

Symbol & atomic No.	Hf 72	Ta 73	W 74	Re 75	Sixth
Atomic weight.	178,6	181,5	184,0	188,7	period.
Symbol & atomic No.	Th 90	Et or Pa 91	U 92		Last
Atomic weight.	232,1	?	238,1		period.

HOW ELEMENT 91 FITS INTO THE PERIODIC TABLE

All of the (presumptive) 92 chemical elements have now been discovered except two, Numbers 85 and 87. Chemists in various laboratories are engaged in more or less persistent efforts to isolate these two and it is unlikely they will be able to "hide out" much longer contain large amounts of silica and iron oxides. They are first boiled with concentrated acids, which dissolve all the iron and other soluble oxides, leaving the "silica residue," which contains Element 91. This residue is melted with alkalies and the melt is extracted with water. This dissolves all the silica and leaves a small precipitate, containing the Element 91 in the concentration of 1 to 10,000. The latter is dissolved in dilute acids and from this solution protactinium is separated, together with the metal zirconium, as a phosphate. By a special method, called by the author the "spiral process," Element 91 is separated from zirconium and freed from all other impurities.

The United States and Belgium are the only two countries in the world which can supply the raw material for protactinium production on a large scale. In the wastes of American radium factories which work up the uranium ores from Utah and Colorado, more than 100 grams (.22 pound) of protactinium are stored, an enormous quantity when we consider that the world radium production since the discovery of that element does not amount to more than 350 grams (three quarters of a pound). Belgium produces radium from rich uranium ore imported from her colonies in Africa. The amount of protactiniferous wastes is much smaller than in the United States, but probably of a better quality.



PHOTOGRAPHIC EFFECT

Five milligrams of protactinium in a small box placed for a few minutes on a plate wrapped in light-proof paper

PROTACTINIUM is thus a very new scientific baby—and nobody knows what use it will find in the future. Nothing has been done as yet to find an industrial and commercial application for it. Evidently much larger quantities than the small amount which constitutes the whole present world production of this element are needed to start experiments. However it is not likely that protactinium will replace radium, for the latter produces in a shorter time a larger amount of effective radioactive disintegration products than protactinium.

In medicine, Element 91 ought to find a different application than radium salts, as protactinium compounds behave quite differently in the body of living beings.

Protactinium is the only radioactive element that can be obtained as a metal. It can therefore be formed into sheet and wire and alloyed with other metals. Perhaps on account of this property protactinium will be of some value later on.

One definite advantage which may accrue from the research is the possibility of getting actinium. This element is 2000 times rarer than Element 91. It has therefore never been seen by human eyes, although it already has a practical application, in extremely diluted form, in radiotherapeutics, as it is over 100 times as active as radium. Actinium atoms are constantly being born from the mother substance, protactinium, and since the latter is now obtainable in a pure state it is extremely easy to separate the "baby," actinium, from protactinium and prepare it in visible quantities.

Large quantities of Element 91 are required for purely scientific research work. When they shall have been obtained it will be possible to answer many important questions about the chemistry and physics of this element. Then the so-called "actinium riddle" which has bothered scientists for 20 years and which Prof. A. S. Russell of Oxford, a leading British radiologist, recently termed "one of the outstanding problems of radioactivity," will be solved. It is the riddle of the origin of protactinium and the actinium which requires an explanation. Since the protactinium atom dies after having lived 50,000 years, and since our mother earth has existed for many millions of years, the birth of protactinium atoms must take place somewhere and from an unknown mother element of long life.

Certainly anything that will bring us a step further in the science of radioactivity is very important, since it is this science that has furnished a great deal of those fundamental facts on which our present day conception of matter, the atom and the way it is made, are based. From this point of view the scientific importance of Element 91 is probably greater than any commercial value it may acquire in the future.

The technical obstacles in the way of large-scale extraction from radium wastes have been overcome and it is hoped that the difficulties in organizing a production of larger amounts of protactinium will be solved as soon as possible, so that its many still unknown properties may be studied.

HIGH-PRECISION ELECTROSCOPES WHICH DETECT MINUTE AMOUNTS OF ELEMENT 91

These electroscopes will measure the amount of protactinium in extreme dilutions of one part in two billions. They are discharged at a measurable rate by the radiations from the element. The rate of discharge is read through small fixed telescopes at the right

Light Airplane Design Contest Winners

First Prize Awarded to an Army Flyer, Second to a Commercial Designer and Third to a Midshipman

THE Committee of Award in the SCIENTIFIC AMERICAN contest for the best design of an airplane to be built around the Cirrus engine, reports as follows:

"We have carefully examined the designs submitted for the Light-Plane Contest on the following rating system:

General suitability of the plane for training and private use and excellency of the design	20 points
Performance	15 points
Power plant installation	15 points
Construction and ease of maintenance	80 points

and have allotted points to the candidates as follows:

Rigby No. 17	125
Huep No. 2	117
Beebe No. 7	100
Boyvey No. 1	91
Brogden No. 11	84
Chase No. 16	73
Sartain No. 4	73
Davidson No. 9	59
Surgeoner No. 19	59
Eames No. 3	56
Brown No. 12	38
Vining No. 14	36
Burnett No. 13	36
Galloway No. 5	27
Roman No. 8	3
Boer No. 10	8
Hamburger No. 15	3
Elset Melve	Disqualified, Wrong Motor

"In the opinion of all three of us, Mr. Rigby's design was undoubtedly the best both from the point of view of original conception and presentation, and deserves the prize.

"Mr. Huep's design deserves honorable mention.

"It has given us great pleasure to co-operate with you on this, which has undoubtedly done much to further thought in the realm of Light-Plane design."

Sincerely yours
Amelia Earhart
George Palmer Putnam
Alexander Klemin

PRIVATE JAMES P. RIGBY, 65 Squadron, Luke Field, T. H., therefore receives the SCIENTIFIC AMERICAN Gold Aviation Medal and 500 dollars. F. R. Huep, 1618—9th Street, Des Moines, Iowa, receives a similar silver medal and Midshipman R. P. Beebe, United States Naval Academy, Annapolis, Maryland, receives the bronze medal. It is interesting to observe that all three branches of our flying activities are represented among the winners.

Because the winners are so widely scattered, it was impossible to make a personal presentation and the prizes were sent to each without further ceremony. In our February issue we will publish details of the winning design.

ALTHOUGH a cablegram was dispatched to Mr. Rigby in Hawaii immediately upon receiving the decision of the Committee, we have not, at the time of going to press, received a photograph of him, or the interesting details of his career such as we publish below for the second and third prize winners. Therefore, we will include these when we publish the details of the winning design.

F. R. HUEP, 28 years old, was born and received his technical education in Germany. He was a designer for the Heinkel and Albatross airplane factories, later becoming assistant to Dr. Lackmann, co-inventor of the slotted wing and other safety devices. In 1926 he came to the United States and designed the Hurd low-wing monoplane H. M. I., and is at present chief designer for the Bolte Aircraft Company of Des Moines, Iowa, for whom he has designed and built three types of low-wing planes. He is a member of the S. A. E.

MIDSHIPMAN R. P. BEEBE first became interested in airplanes in Manila where his father, Col. R. E. Beebe, was then stationed. He has passed through all stages from model building to flying solo. In his high school days he spent many hours in the Air Service Library at Washington studying design. A brother is in the same class at West Point.

Congratulations to the winner and appreciative thanks to the Committee who so helpfully and efficiently worked out the *modus operandi* and rendered their decision. Thanks are also due to Col. R. Potter Campbell for his generous support of aviation by providing the prizes in this contest.

How Well Does the Car Stand Up?

Grueling Tests on Proving Ground Show Capabilities and Characteristics of Cars

By H. F. OLMSTED

"ONE hundred and twelve miles an hour! What if a tire should blow out?" The speaker stood along the inside rim of one of the high banked turns of the Packard Motor Car Company's proving ground 2½-mile speedway and watched as Colonel Charles A. Lindbergh roared past every 80 seconds at the fastest speed he had ever made on the ground.

But "Lindy," who was driving the car as a lark, was as safe from any danger in case a tire had blown out as if in his own *Spirit of St. Louis*. One or all four tires on the Packard speedster which he was driving could have blown on either of the two big curves of the track and the car would have kept going without wavering from its course. The track is so built that when a car once enters one of the turns it will hold to its course without a hand on the steering wheel. It actually can be steered by the accelerator pedal.

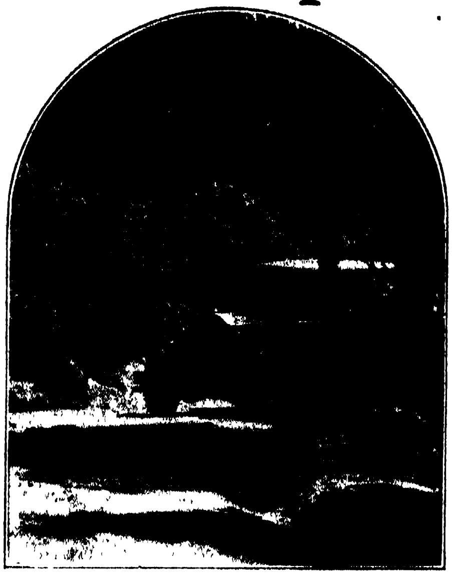
This is one of the many interesting features in the big 500-acre plant which is used for testing Packard cars. A crew of experts who the year 'round drive cars about the big concrete oval at top speed, bounce them over roads as rough as they can be and still have any claims to being roads, or put them through any of the many other tests with which the proving grounds abound, have found that blowing tires at 75 or 100 miles an hour is one of the least of the dangers confronting them at high speed.

Sleep probably would be numbered by any one of the drivers as the greatest menace to safety. Ring-neck pheasants would be the next. Collision with other cars would not enter at all nor would the blowing of tires. Sleep has caused the only accidents which have occurred on the track. Pheasants several times have threatened accidents.

Stamina of a motor car is tested by starting it out on the track at the fastest speed of which it is capable and holding the throttle wide open for many days and nights with stops only for gas, oil, water, or the changing of tires or drivers. Monotony grows with ceaseless circling of the track. Screaming of the wind made by the speed of the car, blending into the singing of the tires on the concrete, the drivers have found, is as effective a sleep producer as the croon of a southern mammy's lullaby.

A year ago the driver of a sedan under test went to sleep while travelling 80 miles an hour. He woke up as the car was leaving the track on its first bounce. It rolled over five times. The driver escaped without a scratch and the car was unharmed. It was an extra, impromptu, but most effective test of the stamina of the body construction. Since then precautions are taken constantly to guard against sleep.

THE proving grounds are located near the village of Utica, 20 miles north of the company's factories in Detroit. It is a section abundantly supplied with small game, most numerous of which are ring-neck pheasants. Several encounters have occurred between the pheasants and cars and each time the car has scored "dead bird."



LIKE A COUNTRY ROAD

One of the test roads on the Packard Proving Ground, simulating an unpaved, rough byroad such as is often found

Pheasants are fast-flying birds and travel with the directness of an arrow. Several times they have been struck when shooting across the track. Each time the car was an enclosed model and the bird failed even to crack the non-shatterable glass of the windshield against which it struck. Drivers think of the pheasants as an actual menace while traveling at high speed in open cars with the windshields folded down. They also say it is humanly impossible not to "duck" the head down when a bird crashes into a windshield or window of an enclosed car, although knowing the glass can do no more than crack, without flying into pieces as would ordinary glass.

It is considered remarkable that accidents, even those of slight nature, are most infrequent, as the day's work of the testers consists of putting cars through the most severe kinds of

SPEED AND MANEUVERABILITY

At the left is shown the oval track on which speed tests are made. On the irregular track at the right, cars are run at high speed, around sharp curves, through sand traps, up difficult inclines, and over bumpy ground. Several cars may be seen on track

ON THE CURVE

The corners on the oval speedway are so curved transversely that a car, traveling at speed, will steer itself if a tire should blow out

ON THE STRAIGHT-AWAY

This track is so safe that the worst thing the drivers have to contend with is sleep due to the monotonous hour-by-hour grind

trials many times with the avowed purpose of trying to cause some part to break.

The proving grounds extend for a mile along one of the main highways leading from Detroit to Northern Michigan. In the whole establishment the company has combined a vast amount of beauty with the utility of the place. In a large lodge house set back some distance from the main highway in a profusion of trees and shrubbery are living quarters for the superintendent, offices, quarters for drivers and engineers, a large garage, and a complete short-wave radio broadcasting station.

ANOTHER building in the rear and across a paved court from the main lodge houses a complete installation of testing apparatus, including dynamometers and a machine shop. It also contains the boiler room which provides heat for all of the buildings, and houses machinery of the water pumping system, a plant large enough for a small city.

A double drive from the buildings to the track is flanked by a putting green and a four-hole "golf course."

The timing stand is at the end of the drive where also is located the main entrance to the track. A complete equipment for recording weather conditions is located in the timing stand where the electric timing device also is set up.

The testing track is an oval consisting of two parallel straight-aways each three quarters of a mile long, joined at each end by a half circle one half mile long. The inner circumference is two and a half miles. The curves at each end consist of three sections; the first has a slope of one degree for drainage, the second rises 11 degrees, and the third section 29 degrees. Driving around the curve, one has a strange optical illusion. The first section seems to slope sharply toward the rest of the track. Often during heavy rains water draining off the track seems actually to be running up hill.

On the center section, with the slope of 11 degrees and the large radius of curvature, any side thrust is canceled at 60 miles an hour, so that at this speed a car will steer itself. Higher speed carries a car up onto the third or high-speed section. Here there is no side thrust at 100 miles an hour and a car actually would steer itself at this speed.

So scientifically planned was the track that it has the record for the fastest time ever made on any circular speedway in the world. This was established by Leon Duray, well known race driver, when he made one lap with his special racing car at the rate of 148.17 miles an hour.

Inside the track is a 265-acre landing field, with mile-long runways, which is used by the company for testing planes equipped with the aircraft motors which it builds. It was from this field that the first airplane powered with a Diesel type engine was flown. A hangar at one end of the field houses the test planes.

One of the most serious construction problems encountered was presented by the landing field. It was a waste of sand, a miniature desert, and farmers of the district shook their heads when they learned that it was planned to develop the area into a lawn. Experts were called in. One hundred tons of fertilizer were used and 41,000 pounds of grass seed were planted while at the same time the whole field was sowed with oats which, it was believed, would take root quickly and hold the sand long enough for the grass seed to germinate and make a stand strong enough to hold the sand alone. The entire field is now covered with a thick sod.

BEYOND the testing track is the "rough ground" and the test roads. The roads—gravel, sand, and plain old-time country dirt—turn and twist all over the place and are so designed as to give the hardest kind of a test to all parts of the car, including the steering gear.

At one point along the test roads there are two artificial hills which, with other dips, give the effect of a roller coaster. Another much steeper hill has been built up so high that an excellent view from the top is obtained of the whole proving grounds and the surrounding country. A miniature desert is provided at another point. It is enveloped in a cloud of dust when cars are sent plowing through its deep sand during test work.

While hills are located along the test roads, enigmatical as it sounds, real hill climbing tests are conducted on the level stretches of the speedway. On the flat concrete, mountains of any grade and of any length are simulated perfectly by a device known as a towing dynamometer.

The towing dynamometer is a car which is towed behind the car under test. An air compressor takes the place of the motor to give the dynamometer car the most powerful braking effect. The frame is loaded with hundreds of pounds of lead to give the wheels greater traction. The towing bar has a piston at one end which works in a hydraulic cylinder. Pressure in this cylinder is registered on gages on the dash so that there is a constant record of the draw-bar pull.

Compression in the air compressor can be regulated through relief valves at the will of the observer in the driver's seat of the towing dynamometer. If a heavy grade is desired the relief valves are set to the proper point. They are so calibrated that any percentage of grade can be maintained.

THE big Packard proving grounds well illustrate to what extent some companies in the automotive industry go in constantly striving to better the quality of their product. It is the largest plant created for proving and improving just one kind of car and represents an investment of well over 1,000,000 dollars. Only a few years ago proving grounds were unnecessary for all motor cars, as engineers had no difficulty in finding many ways of making improvements. Motor cars of better quality, however, have now reached a state of refinement where the most enhaustive tests are necessary to discover means of betterment and to make certain that the quality of the car is being constantly maintained.

ESTABLISHING A WORLD'S RECORD BY PLOWING, DISKING, SEEDING, AND

Mass Production

Large-Scale Farming Operations May Be Revolutionized

By HENRY

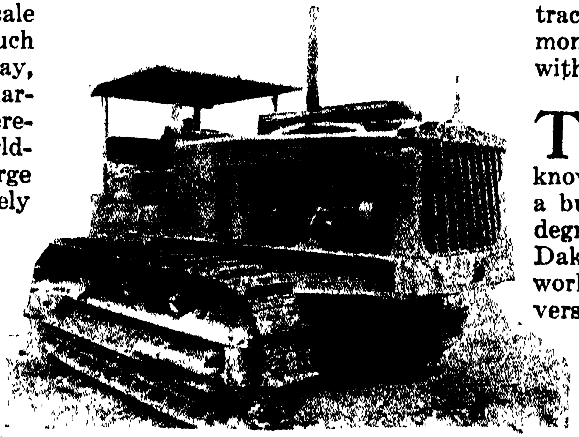
WHEELS—big wheels and little wheels—with ample power to keep them turning day and night until the last of the fleet of tractor-drawn combines has threshed its last bushel of grain—that is the story of harvest-time at the 95,000-acre farm of the Campbell Farming Corporation, which occupies part of the Crow Indian Reservation in Montana. Agriculture a-la-Detroit is the *pièce de résistance* on this tremendous farm, where the production of nearly a million bushels of wheat a year is accomplished by means of the most advanced farm machinery, mass-production methods of operation, and an up-to-date system of cost accounting.

Power is obviously a factor of paramount importance in such large-scale farming operations, where as much as 1000 acres can be plowed in a day, and 2000 acres can be seeded or harvested. One is not surprised, therefore, that the attention of the world-famous agricultural engineer in charge of these operations has been lately focused on the most economical power source yet perfected—the Diesel oil-engine.

SEVERAL tractor manufacturing concerns have been experimenting with Diesel engines, and recent experiments and field tests in a 400-acre field on the Campbell farm indicate that the gasoline-driven tractor is perhaps soon to become as obsolete as its steam-driven forerunner.

The tests were revolutionary, according to Mr. Thomas D. Campbell, President of the Campbell Farming Corporation. "With an Allis-Chalmers Monarch tractor powered with a Diesel engine operating on furnace oil, plowing costs were cut to about one seventh the usual figure. Pulling 10 plows at a depth of about 10 inches the tractor plowed the 400-acre tract at a rate of 36 acres per ten hours of operation. With more efficient operating methods, I am confident that the Diesel engine will enable us to reduce our expense for heavy plowing to about one tenth the usual cost when operating tractors powered with gasoline engines.

"Of course the Diesel engine is somewhat heavier than other types of internal combustion engines. However, in a tractor this factor is an asset rather than a liability, particularly when operating with a heavy drag. I believe that the next ten years will be an era of Diesel-driven tractors. This development is of outstanding importance, for more power is required to plow the farm lands of the United States, in the time they should be plowed, than is needed to operate all other industries together, including our great transportation systems."



Courtesy Allis-Chalmers Manufacturing Company

A DIESEL-POWERED TRACTOR

Tests on the Campbell farm with this tractor powered with a Diesel engine inaugurated a new era in power farming operations of the type practiced in the west

Agricultural engineers have observed and analyzed Mr. Campbell's operating and production methods, and have studied his simple but highly successful system of cost accounting. Farmers, economists, and the general public have listened to his enthusiastic description of the Campbell brand of farming, seeing in the far-flung operations of the corporation a more scientific scheme for feeding the world. Manufacturers of farm machinery seem to regard the Campbell farm as a proving ground for various types of new equipment designed to increase production of agricultural products on a more economical basis.

A "farm hand" would be as much of a novelty as a horse or a cow on this farm; the workers are mechanics, who are paid mechanics' wages, or work on a basis of mileage covered with an attractive cash bonus at the end of the season. High wages, comfortable living quarters, and a relatively large degree of individual responsibility attract skilled workers of an uncommonly high type, many of them men with technical training.

TOM CAMPBELL, as the head of the corporation is generally known, is an engineer, a farmer, and a business man. After receiving two degrees at the University of North Dakota, and taking post-graduate work in engineering at Cornell University, he took over the management of the family farm in the Red River Valley in North Dakota. A few years later he was engaged in various large-scale agricultural development projects in California. When the war-torn nations of Europe turned to the United States for emergency supplies of wheat, Mr. Campbell secured the financial backing of a group of internationally prominent bankers and began to raise wheat on an unprecedented scale, making use of large areas of unproductive government land.

"Dry farming" on the semi-arid plains of the west has broken the spirit of thousands of homesteaders farming relatively small tracts with unscientific methods and inadequate

PACKING 640 ACRES IN ONE DAY, WITHOUT A HALT FOR MECHANICAL TROUBLE

In Agriculture

By Means of Tractors Powered With Diesel Engines

W. HOUGH

equipment. To raise a paying crop on barren prairies with only about 15 inches of rainfall a year and temperature variations from 40 degrees below zero to more than 100 degrees above, is an undertaking that requires sound knowledge, skillful management, and a reasonable amount of luck. About the time Mr. Campbell was launching his project in southeastern Montana, agriculture in that region went through the worst period in its history; parching drought destroyed one crop, myriads of grasshoppers consumed another, and the first good crop was made valueless by the utter collapse of the wheat maket.

THOUSANDS of farms were abandoned, but Mr. Campbell secured new capital and carried forward his carefully made plans. Planting only half the usual amount of seed to the acre, in order that whatever moisture might be available would be used to best advantage, he raised a good crop and marketed it at a substantial profit. Since then his operations have been successful every year, and as the total acreage in crop increases, production costs go down. When he wishes to increase his output, Mr. Campbell pays his men higher wages and the average production per man increases to a new high level.

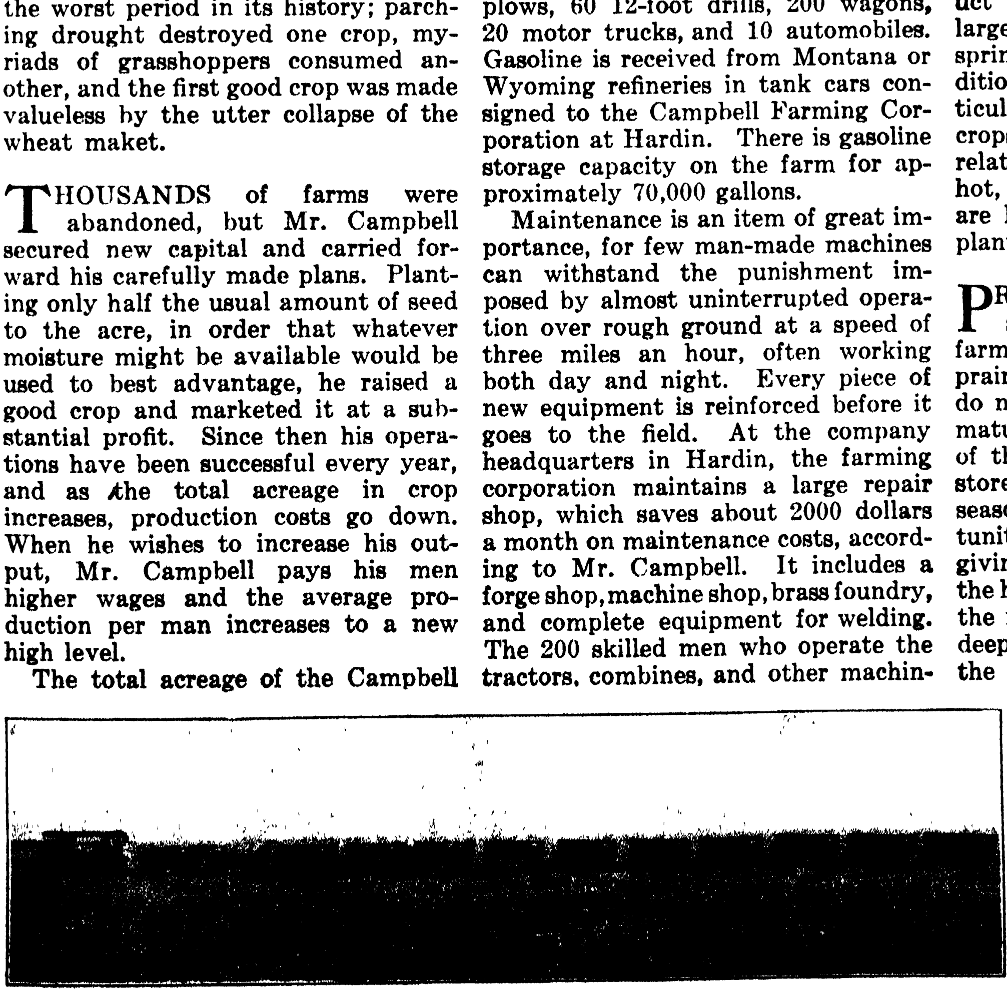
The total acreage of the Campbell properties is sub-divided into units of from 5000 to 32,000 acres. With 640 acres to one square mile, it will be seen that the Campbell farm occupies about 150 square miles. To take an inventory of the equipment would seem to be a good job for an aerial photographer; when listed, the more important types of machinery represented would include 56 tractors, 72 binders, 21 combines, 11 threshing machines, 500 plows, 60 12-foot drills, 200 wagons, 20 motor trucks, and 10 automobiles. Gasoline is received from Montana or Wyoming refineries in tank cars consigned to the Campbell Farming Corporation at Hardin. There is gasoline storage capacity on the farm for approximately 70,000 gallons.

Maintenance is an item of great importance, for few man-made machines can withstand the punishment imposed by almost uninterrupted operation over rough ground at a speed of three miles an hour, often working both day and night. Every piece of new equipment is reinforced before it goes to the field. At the company headquarters in Hardin, the farming corporation maintains a large repair shop, which saves about 2000 dollars a month on maintenance costs, according to Mr. Campbell. It includes a forge shop, machine shop, brass foundry, and complete equipment for welding. The 200 skilled men who operate the tractors, combines, and other machinery, are able to make most mechanical repairs in the field. The busy season is from the first of September to the first of December. When this period closes, all of the equipment is overhauled completely and put in shape for the coming season. A crew of about 50 selected men attend to the necessary work during the winter months when most of the crop is in the ground.

Winter wheat is the principal product of the Campbell farm, although large areas are also used for raising spring wheat and flax. Growing conditions in eastern Montana are particularly favorable for raising these crops, but producing spring wheat is relatively hazardous because of the hot, dry winds of the summer which are likely to wither and shrivel grain planted in the spring.

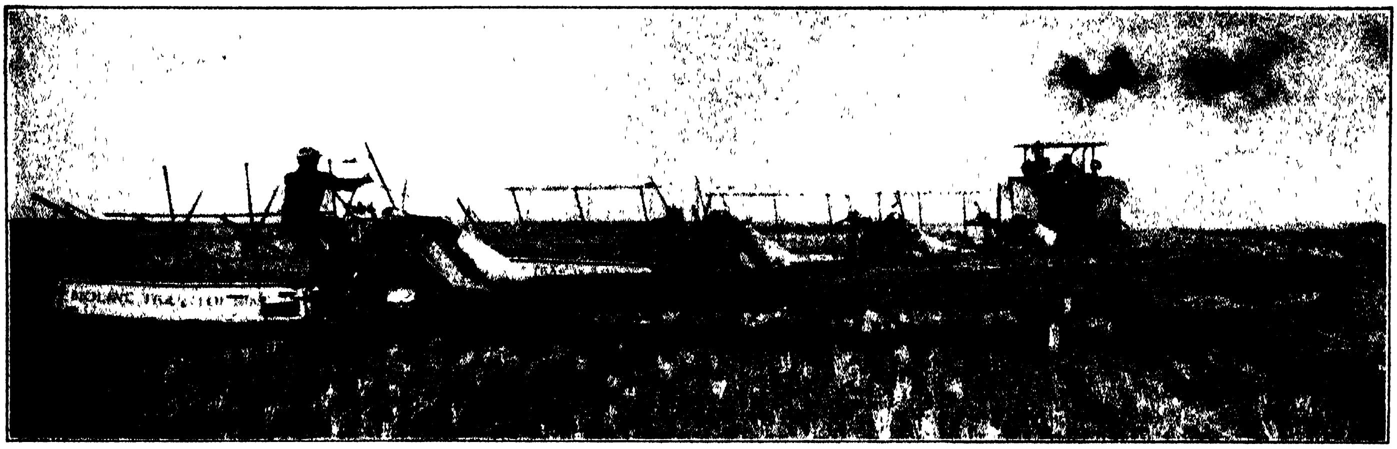
PREPARING the ground for the seed is the most important part of farming operations on the semi-arid prairies. The scant rainfall and snow do not provide sufficient moisture for maturing the crop unless the moisture of the previous season has been well stored in the soil. Summer fallow one season in three gives the soil an opportunity to replenish its supply of growth-giving constituents and moisture. After the harvest, the land is disked to enable the fall rain and winter snow to soak deep into the soil. Early in the spring the fields are disked again, and then left fallow until May. By that time there is considerable growth of weeds and volunteer wheat, which is plowed under for fertilizer, usually with a light duckfoot plow. The soil is pulverized with a spike-tooth harrow later in the summer, and seeding begins early, usually about the middle of September, in order to give the grain time to get sufficiently well established so that it will withstand the rigors of winter.

For the first crop the ground is



THIS LITTLE WAGON TRAIN GOES TO MARKET

Long trains of grain wagons drawn by tractors are supplemented by fast grain trucks hauling two or three trailers, in harvest season. Trains rush the crop to the markets



HARVESTING GRAIN BY THE "WINDROW" METHOD DEVELOPED BY THOMAS D. CAMPBELL

After the wheat or flax is cut and piled loosely in long rows to cure, a tractor-drawn "combine" picks up the grain and threshes it. This method makes the use of the combine practical in almost any agricultural region on relatively small farms as well as large ones.

plowed and disked, but the following year it is simply double-disked, turning under the stubble and the straw scattered by the combines. Plowing costs have been reduced to about two dollars an acre, but disking can be done for less than one fourth that amount. In 1924 the Campbell farm established a world's record by plowing, disking, seeding, and packing 640 acres in one day of 16 hours. Fifteen tractor-drawn assemblies were kept in operation without a halt for mechanical trouble of any kind; the tractors were refueled without making a stop. Now the rate of a section a day can be continued as long as is necessary properly to plant the crop, and 1000 acres a day can be put in when desired.

Profiting by his experience the year of the severe drought, Mr. Campbell uses only about 20 pounds of seed to the acre, or about half the amount of his first seedings. For the second crop only 10 pounds of seed to the acre is used. The usual yield is about 15 bushels to the acre, although in 1924 the yield averaged 30 bushels.

Another world's record was established in 1924. Threshing, now done in most of the important wheat-producing regions with tractor-drawn combines, was then done with stationary threshing machines powered from nearby tractors. With one standard Case threshing machine outfit, 4321 bushels of wheat were threshed in one day of 14 hours. The record is one that will probably stand for all time, because it is now considered more economical to use combines, harvesting "on the run." Threshing as much as 30,000 bushels a day, from 10 to 20 combines are drawn around the enormous fields. An arm with a spread of from 20 to 30 feet cuts the wheat and passes it into the thresher, which pours the grain into a hopper or into a wagon attached to the combine.

Harvesting with combines was impractical under certain conditions, and to remedy this objectionable feature Mr. Campbell developed the "windrow," which is recognized as one of the most important advances in harvesting since the invention of the binder. Using four partly dismantled binders drawn by a light tractor, a 40-foot swath of grain is cut and transferred unbound to a long row, where the loose grain is allowed to mature for a few days before threshing. Then a combine is hauled down the long row, picking up the grain with a hay loader, and threshing it in the usual manner. This method effects a saving of two dollars an acre on harvesting costs, compared to the old method with binders, bound shocks, and stationary threshers. Due to the extra width of the spread or swath cut, the cost of the two windrow operations is comparable to that when combines are used in the regular manner.

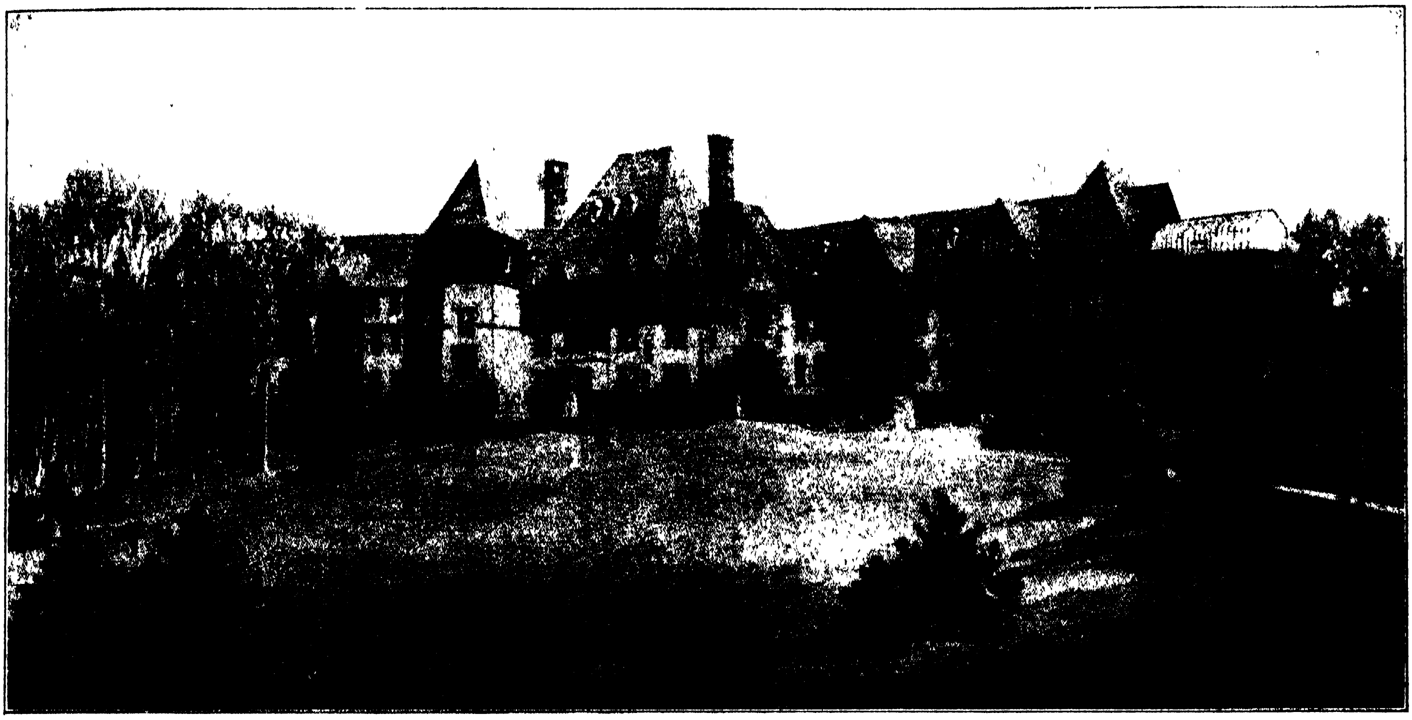
LONG wagon trains drawn by tractors, supplemented by motor trucks equipped with large bins and drawing two trailers, transport the grain to the railroad, elevators, or storage bins. Most of the Campbell grain goes to Minneapolis, the largest flour producing city in the world. Millers feature flour made with Montana wheat, and pay extra premiums for the Montana grain because of its unusually high protein content. The premium on high-protein wheat varies from two cents to about 30 cents, according to the milling demands and the abundance of the premium grain. On the Campbell properties near Hardin there is storage space for about 150,000 bushels of grain, for protection against an unfavorable market.

When one contrasts the high-speed, mass-production methods of modern industrialized agriculture with the more leisurely, more enjoyable, but obviously less economical practices still in vogue in most of our agricultural regions, it is not hard to realize that 30 percent of our farmers produce 80 percent of our crops and livestock. During the past 20 years about five million people have left the farms, but the total agricultural output has increased; by 1950 there will probably be about 150 million people in the United States, and they will be fed by fewer farmers than were required in 1850 to feed only 25 million people. Three men operating a tractor combine can do the work of 18 threshers, and it now requires only 10 minutes of human labor to produce one bushel of wheat whereas it formerly required about three hours.

What the farmer really needs, in the opinion of the world's largest wheat grower, is better machinery, improved inland waterways, closer co-operation between farmers and business men, more agricultural research, education regarding economical production methods, tariff protection, better co-operative marketing associations, and improved equipment to provide cheap power for farming operations. Anyone who intelligently follows the advice of the Department of Agriculture and the agricultural colleges can make farming pay, especially if trained in engineering practices. Mr. Campbell expects to be operating his tractors with individual electric motors supplied with power distributed from a central generating plant on his farm, within another 10 years. In the meantime, he considers the Diesel engine the most economical power source for use on farms.

It is Mr. Campbell's belief that the greatest industrial opportunity of the present time is in agricultural engineering, both as a life work and as a sound financial investment. In a recent issue of *Mechanical Engineering*, the editor said, "Mr. Campbell's experience indicates that the application of machinery on a large scale is successful in producing wheat and flax at low cost. It is logical to believe that the principles he has developed and used so successfully can be applied to other farm products. As engineering skill has made over industry generally, so it can remodel agriculture, transforming it from a method of making a living to a sound industry that will attract the best brains and capital."

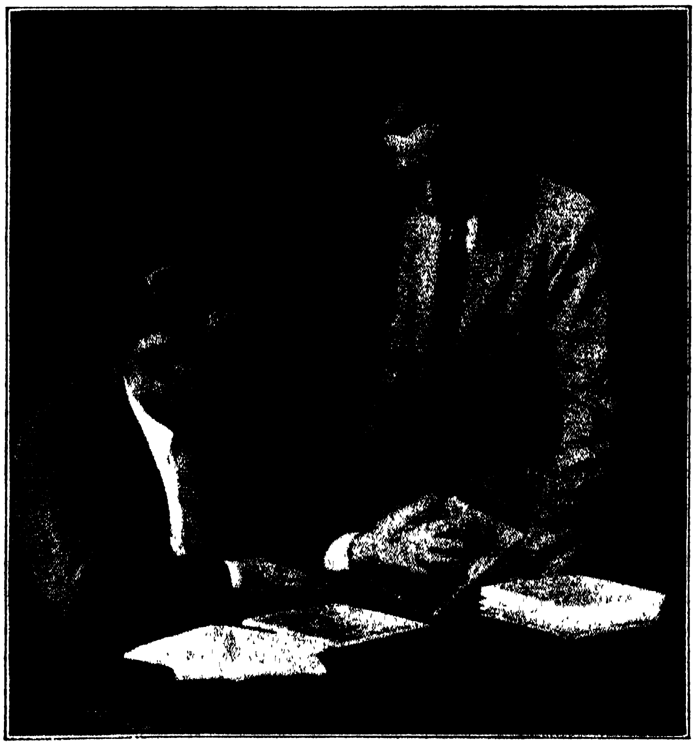
Fuzed Quartz for Ultra-violet Rays



THE NEW FUSED QUARTZ SOLARIUM

The enclosure, entirely of quartz panes, is shown (upper right hand corner) on the roof of the National Vaudeville Artists' Sanatorium

PLACING TRAYS OF CRUSHED CRYSTAL QUARTZ IN FURNACE



INSPECTING PANES OF THE FUSED AND FINISHED PRODUCT

IN order to permit patients to receive indoors the maximum percentage of the especially valuable short wavelength ultraviolet radiation of the natural sunlight the sanatorium shown above, at Saranac Lake, New York, has installed an expensive solarium walled and roofed entirely with panes of fused quartz, 1200 of them, each 7½ inches square and ¼ inch thick. Common window glass, transparent to the visible rays of light, is almost totally opaque in the short-wave ultra-violet part of the spectrum. Various special glasses and glass substitutes transmit up to about 50 percent of these rays, while fused quartz transmits the greater part of them. The quartz panes were made by the General Electric Company, using a special technique developed by Professor Elihu Thomson of that company, who is also a Corresponding Editor of this journal. Quartz is difficult to work because it melts only at 3200 degrees, Fahrenheit—three times the temperature required to melt glass. Even then it is thick, ropy, and viscous. In making the window panes, natural quartz crystal is crushed to ¼ inch mesh size and spread on graphite trays between graphite slabs. Several trays are stacked as shown above, placed in a high temperature furnace and fused. The troublesome bubbles imprisoned in the mass are compressed to a minimum size under 150 pounds per square inch of inert gas (nitrogen) admitted to the furnace. The panes are cooled, their edges are squared by grinding, and they are ready for use.

Your 1930 Car

A Survey, in Brief, of Developments, Improvements, and Changes in Design of Some of the Better Known Cars

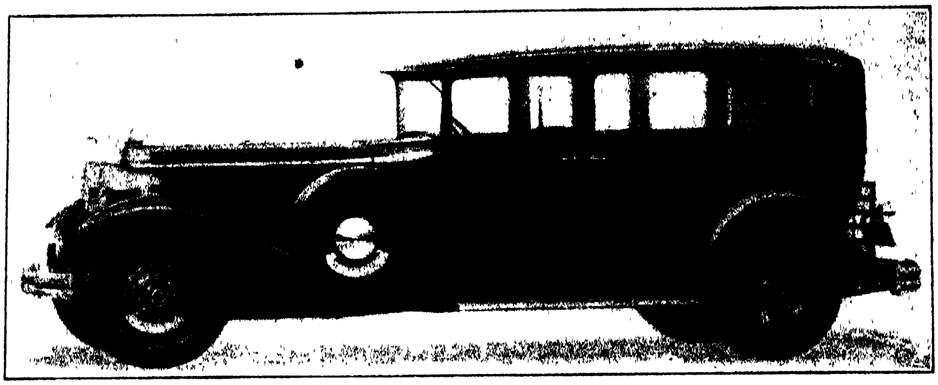
By F. D. McHUGH

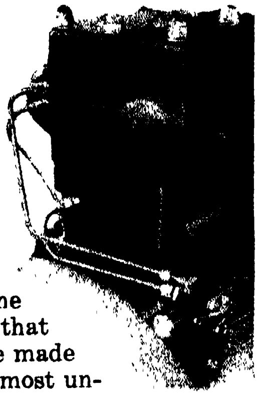
WHEN you come to the task of selecting your new car this year, you will find that you have taken upon yourself a more difficult job then heretofore—unless, of course, you are partial to a particular make. Practically all the better known cars have refinements that will appeal to your desire for speed, for safety, for appearance, et cetera; but, in general, many of these features balance each other in different makes so that, to a large extent, you will have to guide you only the limitations of your purse and the knowledge you already have as to car performance and reliability.

And yet with all the refinements that have been made, mechanical improvements this year are not numerous. Some outstanding ones, however, indicate the intention of the manufacturers to build for you an ever finer, safer, more powerful, or more attractive car.

ON page 9 of this issue, Mr. C. F. Kettering outlines this development problem and describes the constant research that it is necessary for the manufacturer to conduct, but he does not stress the fact that whatever improvements are made come very gradually and almost unknown to the average motorist. We shall therefore outline briefly what appear to us to be the most noteworthy refinements and improvements that have been made recently and others that are to be announced shortly.

In general, it may be said that improvements are limited to such details as spring shackles, carbureters, rumble seat doors, and the more general adoption of four-wheel brakes, of safety glass, and of other safety features. Several manufacturers, however, have greatly increased engine power. A few cars have been equipped with newly developed devices which add much to engine capacity, to riding comfort, or to ease of driving.





PACKARD LIMOUSINE AND PISTON OILER

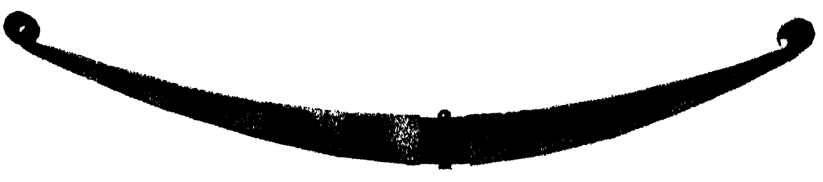
The luxurious seven-passenger sedan limousine presents a striking appearance. At the left is the choke-operated valve which sprays oil into each cylinder

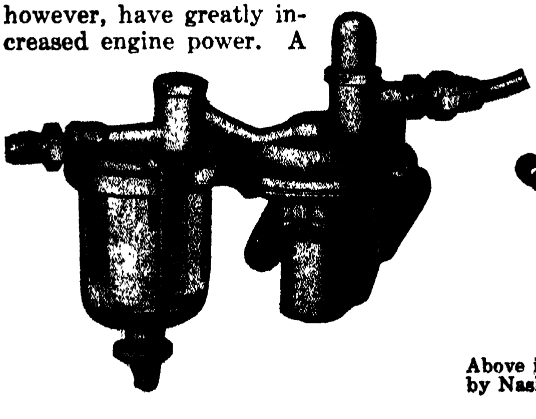
The desire for color, fostered by the judicial use of it for several years and by almost a sunburst effect in the cars of 1929, is proving to be no fad but a method of expressing the car owner's individuality. In 1930 there will be a marked increase in color used on many cars. In fact, color has become such an important factor in the production of automobiles that manufacturers have employed color directors—artistic experts who know how to harmonize color combinations with individual designs.

Before going into further detail, we wish to refer you to the article on the Cord front-drive automobile on page 28. This is the most radically new design in American passenger automobiles for 1930. Besides this car, several makers of sixes have recently announced production of new eights and it is rumored that others will come into the market soon. Also, it has been stated authoritatively that a new 16-cylinder passenger car will be announced in March or April by a manufacturer of cars in the higher price range.

New Packard eights announced in the fall, characteristically Packard in appearance but with subtle changes that add much to their already famous beauty, have several outstanding improvements. Both the driver's seats and the steering wheels are adjustable. Unusual vision is given in the front compartment by a front body pillar that has been narrowed, yet retains the same body strength. All windshields and windows are of non-shatterable glass. The left front spring trunnion, developed by this company a year ago to eliminate "shimmy" and wheel "whip," has been retained. The chassis lubricating system has been extended to include 43 points on the chassis which are oiled every day by turning a pump handle mounted within easy reach at the base of the steering column.

PACKARD has also developed a new carbureter which is said to have many advantages in smoothness of operation, acceleration, safety, quietness, economy, and easy starting. Steel-backed bearings and several other features found by the company to be of advantage in building airplane models are incorporated in the new engines. As in previous Packards, the



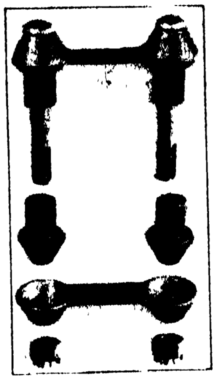


NASH DEVELOPMENTS ON THE TWIN-IGNITION EIGHT

Above is shown the manner in which the springs are steel-jacketed on the new eight announced by Nash. At the left is the gasoline filter and fuel pump which makes positive fuel feed possible pistons are automatically lubricated when the choke rod of the motor is pulled out, an arrangement which pumps oil onto the cylinder walls at the time it is most needed.

With three complete lines, each comprising 11 different types, and an almost unlimited choice of individual custom bodies by the best body builders, Packard may now be said to cover completely the fine car field.

One of the eights recently announced by a maker of sixes is the Nash twin-ignition straight-eight which the Nash Motor Company claims is the first of its kind in the world. Included in the announcement were details of a twin-ignition six and a single six. The new eight is powered by an eight-in-line twin-ignition, valve-in-head, nine-bearing motor with an integrally counterbalanced, hollow-pin crankshaft; with aluminum alloy Invar-strut piston and aluminum alloy connecting rods capped at the crankshaft with case-hardened steel. It develops 100 horsepower.

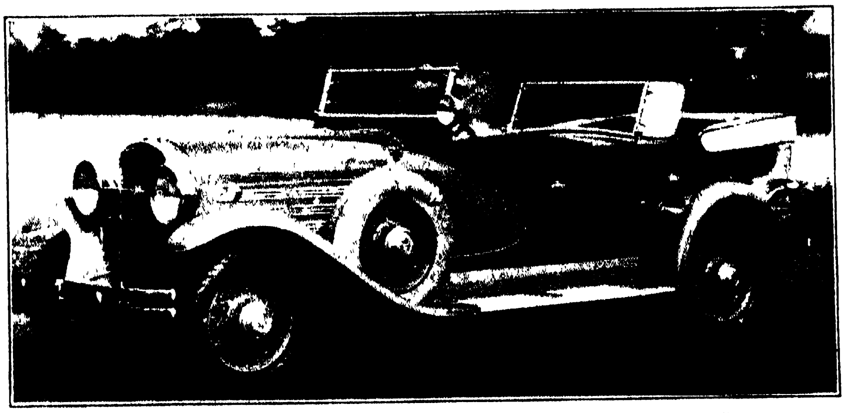


NEW features of the Nash eight include: steel-jacketed lifetime-lubricated springs, individually tailored to the weight of each car; cable-actuated internal-expanding four-wheel brakes which are self-energizing forward and backward; thermostatically controlled radiator shutters; Bijur centralized lubricating system to oil, by pressure on a foot pedal, 21 chassis points, including shackles; dash-bottom starting controls; et cetera.

Various mechanical and body refinements have been incorporated in the Nash eight. These include aircraft-type spark plugs, positive fuel-pump gasoline feed, solid chain-operated camshaft, improved clutch, and road-shock insulator. Most of these features will be found also in the two sixes while both the eight and the sixes have non-shatterable glass in windows and windshield.

Hupmobile is another producer of a new eight in the medium price class. This car is manufactured in five body styles, one of which, the cabriolet, has a patented top construction. The new eight develops 100 horsepower, is said to attain an 80-mile-an-hour speed, and accelerates rapidly.

In these new Hupmobile eights, the radiator is higher and narrower, has built-in shutters, a new emblem, and a narrow chromium-plated shell. Among other improvements, this car has also adopted the road-shock eliminator attached to the rear end of the left front spring, and force-feed lubrication to all main, connecting rod, and piston pin bearings—46 points in all.



JORDAN "PLAYBOY" AND SPRING SHACKLE

An attractive sport touring car. At the left is shown the rubber insulated spring shackle, disassembled to show parts. Rubber sections are dark

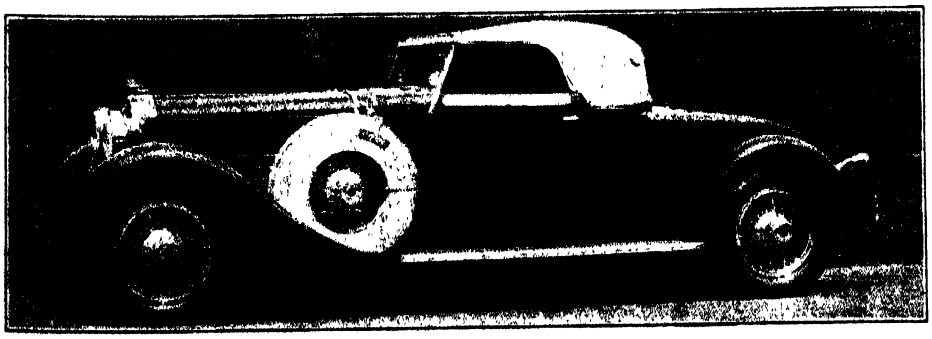
A third new eight is the Gardner with an eight-in-line motor and optional four-speed transmission. This new car comes in two series, in each of which there are eight models. Information concerning mechanical details of this new eight are not available but it is said to have several improvements.

Several features of the "Great Line Ninety," an eight by Jordan, with a 75 horsepower, eight-in-line motor, reflect this company's claim of "scientific engineering." This eight has a crankshaft that is both statically and dynamically balanced and is therefore free from periodic vibration; it has pressure lubrication of main and connecting rod bearings, a double breaker ignition distributor, and other distinctly Jordan developments. Other features are: soft type chassis springs of special alloy steel, Houdaille shock absorbers, seat cushion springs which are said to be synchronized with the chassis springs, and new patented shackles, mounted in rubber to eliminate rattles and squeaks.

The Stutz Motor Car Company continues to stress the built-in safety features of Stutz and Blackhawk cars. The contribution to safety of the low-slung bodies of these two cars—made possible by the worm gear drive; of the safety glass used in both; of side bumper running boards; of four-speed transmission; and of the vacuum booster on the hydraulic brakes of the Stutz, has been added to within the year by the Noback, an exclusive Stutz engineering achievement which is now on both the Stutz and the Blackhawk.

THE Noback, which the writer considers one of the most important contributions to car safety to be developed in recent years, is a brake with an automatic actuating mechanism. Installed between the rear of the transmission main shaft and the parking brake drum, this device prevents dangerous backward rolling of a Stutz or Blackhawk when a stop is made on an incline, so that it is entirely unnecessary to use the brakes for holding the car. To push one of these cars backward it is necessary to throw the gearshift lever into reverse and then throw it back into neutral. The car may then be pushed or allowed to roll backward; but when a forward motion has taken place, Noback again holds the car as before until the operation is repeated. This company has also adopted, as optional equipment, the first stock supercharger to be used on anything but racing cars and airplanes.

Stutz has just announced a new streamlined aluminum-body speedster, the Torpedo, in which are incorporated many of the features of last year's Blackhawk. Four-speed transmission,

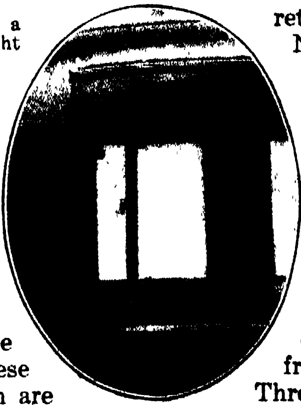


STUTZ, THE LOW-WEIGHTED

This model typifies the low center of gravity characteristic of all Stutz cars. Safety of all models is stressed because of the many safety features, the most recent of which is the Noback

KISSEL DELUXE BROUGHAM SEDAN

In this model may be seen the new "No-draft" ventilating rear side window, a close-up of which, in the open position, is shown in the oval illustration at the right



Noback, the new vacuum-operated hydraulic brakes, and low center of gravity, provide ease of driving and safety for the occupants.

Balance and low center of gravity have become factors of major importance along with increase in engine power and speed. Thus the announcement of Studebaker that the new President eight and Commander eights and sixes are built with double drop frames, reveals a noteworthy development in both safety and balance for the Studebaker line. The low over-all height and low center of gravity made possible by this double drop frame, together with the recently adopted non-shatterable glass for Studebaker windshields, represent the most recent improvements in this line of cars.

THE Kissel Motor Car Company has adopted for all models in series 95 and series 126 a four-speed transmission which the company says is the result of two years of experiment and research work. The result achieved is smoothness of operation and improved road performance, a slowing down of engine and propeller-shaft speeds, and, consequently, decreased vibration. The only other mechanical improvement in series 126 is the adoption of Lovejoy shock absorbers. The bodies of some Kissel models have been enlarged and body lines have been revised. The 1930 De Luxe Brougham has a new style of ventilating rear side window. Exclusively a Kissel feature, this window swings on hinges like a residence casement window. The rear oval window of this model lowers the same as the door window glasses.

Duesenberg, Inc., displayed at the Chicago salon in November nine models built on the regular 265-horsepower Duesenberg chassis. Many new and luxurious features have been incorporated in these new bodies, three of which are by Murphy, two by Willoughby, and one each by LeBaron, Weyman, Derham, and Judkins.

Marmon has re-entered the fine car field with the production of the Marmon Big Eight. Powered with a straight-eight engine of 125 horsepower, this car is equipped with four-speed transmission and especially designed mechanical features such as: a double-dome cylinder head; invariable mechanical four-wheel brakes with cable linkage completely enclosed in lubricant-packed, sealed metal conduits; and mono-control windshield.

ADDITION of this car, built in nine body styles for the higher price class, enables the Marmon Company to blanket the price field since it already produces the Roosevelt in the low price range and the Marmon 66 and 78 in the medium price range. Further information concerning new models will be given out early in 1930.

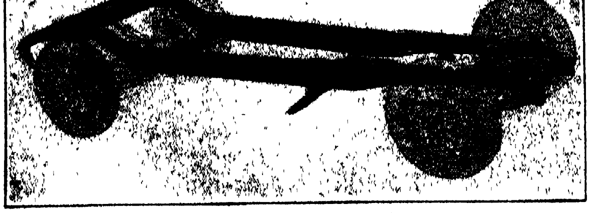
The 1930 Buick will be offered in 14 models in three series known as the "40," "50," and "60" Series. Longer wheel-bases; lower, longer, and more beautiful bodies; and many mechanical improvements and refinements characterize these new Buicks. Additional power is given by the increase of ⅛ inch in the cylinder bore of engines of all models. Other advances achieved are: semi-elliptical rear springs; double-acting shock absorbers; sloping, non-glare windshield; re-designed transmission and clutch; larger rubber motor mountings; thermostatically controlled radiator shutters; and a wider frame. The carburetion system has been improved by a newly designed gasoline pump and the elimination of the low-speed carbureter adjustment.

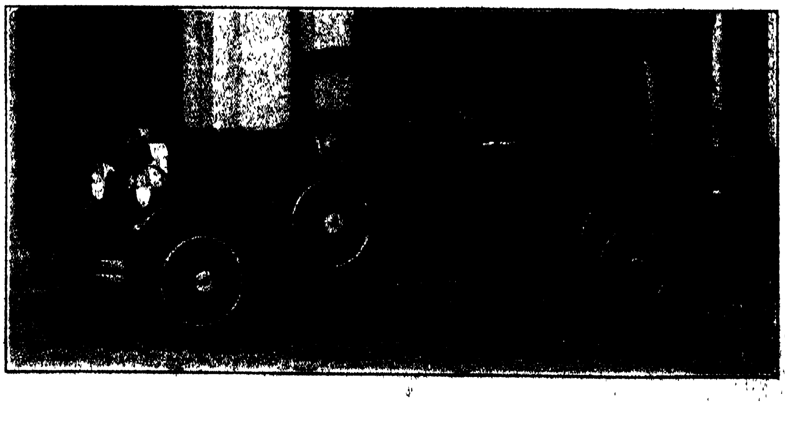
No radical changes have been made in the duPont. The eight models of the new eight which were recently announced are distinctive in design, showing as they do the French body style influence. They have a higher radiator and cowl, with heavily crowned fenders brought to a point in front.

Three new Chryslers, the "77," "70," and "66," were recently added to this well-known line. Noteworthy features in the "77" and the "70" are: multi-range, four-speed gear shift; a down-draft carbureter; larger and more powerful engines; Paraflex spring suspension; and chimney-type, rubber, shock insulators.

IN the "down-draft fuelization" system, the carbureter is mounted above the engine instead of at the side, thus allowing a gravity flow of the explosive mixture.

Another new feature found in these two series is the de-carbonizer, a device employing a new fluid called Carbosalve for dissolving the engine carbon deposits. This device includes a fluid container mounted on the dash under the hood, a connection to the inlet manifold, and a plunger located on the dash. With the engine running, a quantity of the fluid is sent into the cylinders by means of the plunger. After the engine rests several hours and is then started up, the dissolved carbon particles are blown out the exhaust. Chrysler has also adopted a

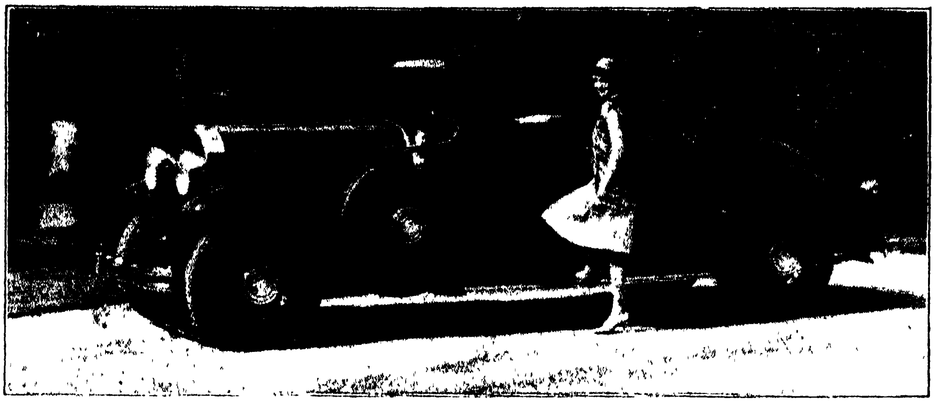




STUDEBAKER CHASSIS AND MODEL

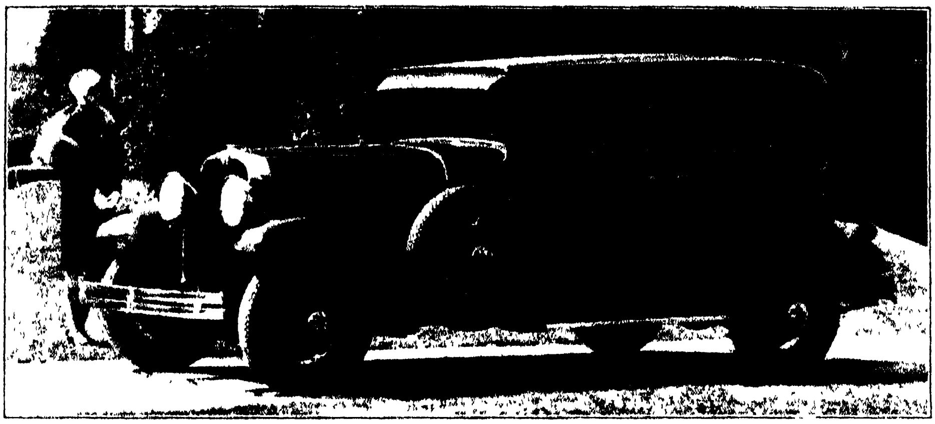
Above is shown the new double-drop frame which gives a low center of gravity and reduces body-line height of the President eight and Commander eights and sixes. At right is the Dictator Eight Brougham rust-proofing process which is claimed to insure a permanent finish and longer life for fenders and other exposed parts. An interesting Chrysler innovation is the rumble seat door which has been added to the Imperial roadster.

Pierce-Arrow, in 1930, will build three groups of cars, all of them straight-eights, although no changes will be made in general appearance or body design. In these cars will be incorporated several improvements over current production which, as a matter of fact, is new, since Pierce-Arrow's first straight-eight car was introduced early in 1929. Among the refinements are some which affect the manifolding; and the latest improvement—a very important one—is the adoption of stainless steel for more than 350 parts including small pieces, nuts, and bolts which would ordinarily be subject to rust or corrosion.



BUICK WILL COME IN 14 MODELS

The 1930 Buicks will have longer wheel-bases and be characterized by many mechanical refinements. Their engines have been given increased power by a larger cylinder bore

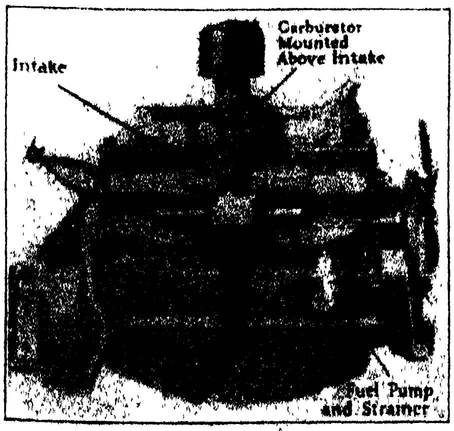


VIKING EIGHT BROUGHAM

This four-door brougham is one of three new models which will be displayed at the annual automobile show in New York in January. Improvements will be announced then

Striking body designs will feature the exhibit of the Oldsmobile six at the New York Automobile Show. The body types on display will include the four-door sedan, two-door sedan, business coupe, sport coupe, convertible roadster, and phaeton, in standard, special, and deluxe models.

The Viking eight, companion car of the Oldsmobile six will be seen in three distinctive models at this show. Designed by Oldsmobile engineers with the resources of the General Motors research laboratories and proving ground at their command, the Viking has improved engine design.

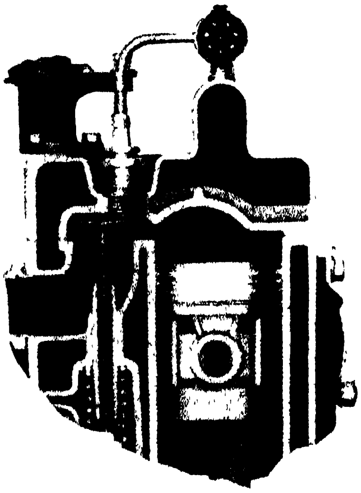


CHRYSLER FUELIZATION SYSTEM

"Down-draft carburetion" is said to give more power, speed, and easier starting

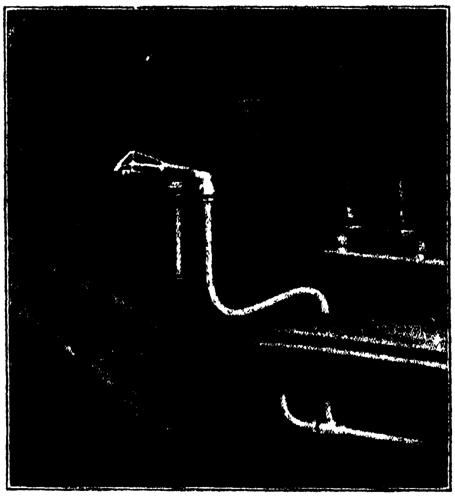
We wish here to extend our thanks to the companies already mentioned for their co-operation with us in the preparation of this article and to express our appreciation to the following who have made an effort to supply us with material but could not release it early enough: Willys-Knight and Whippet, Chevrolet, Auburn, Oakland, the Dodge-DeSoto-Plymouth line, Peerless, and Stearns-Knight. Those who had no information available before the first of the year are: Franklin, Cadillac and LaSalle, Hudson and Essex, Ford and Lincoln, Durant, Moon, Graham-Paige, and Reo.

A review of the automobile field gives the impression that manufacturers anticipate no great let-up in car buying in 1930 despite the recent disastrous stock market crash. It has been asserted that whatever effect it may have had will shortly be offset by a normal car sale and that the output in 1930 will be greater than ever.



MARMON CYLINDER HEAD

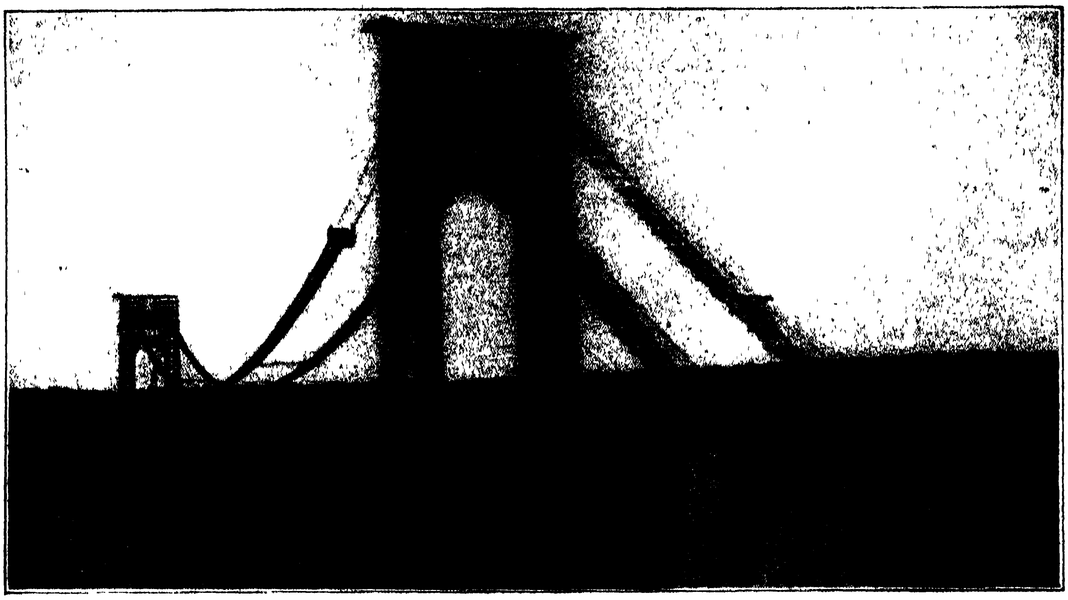
A sectional view of the new double-dome cylinder head of the new Big Eight



CHRYSLER DE-CARBONIZER

Mounting of the new device designed to keep the engine always free of carbon

Most of the 1930 cars, at least in the medium and higher price range, it will be noted, are finer, more luxurious, or so greatly improved as to indicate the belief of the manufacturers in the continuation of our general prosperity. In the low price field, the prices of the 20 models of Fords have been lowered by amounts varying from 15 to 200 dollars. To explain this, Edsel Ford is quoted as saying, "It is our belief that, basically, the industry and business of the country is sound. We are reducing prices now because we feel that such a step is the best contribution that can be made to assure a continuation of good business throughout the country."



ALMOST READY FOR SPINNING THE CABLES

When this photograph was taken, the catwalk cables had been raised to position and the catwalk was almost complete. A carrier, loaded with sections of which this walk is built, may be seen on center span

Four Cables: 106,000 Miles of Wire

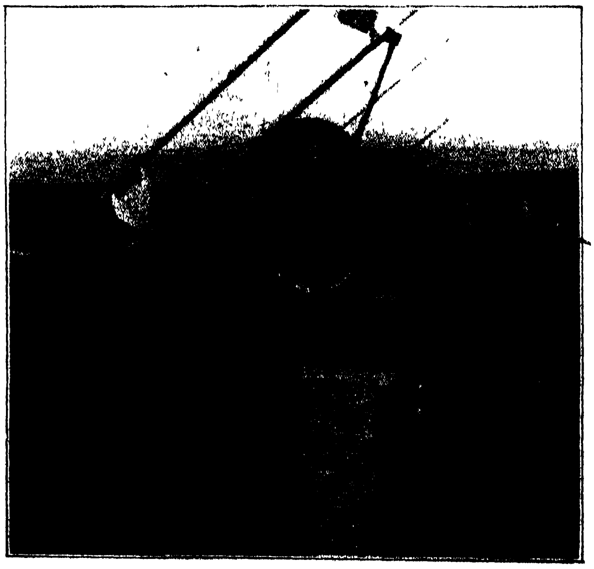
As Spinning of Cables Begins, the Hudson River Bridge From New York City to New Jersey Becomes a Giant "Loom"

By A. E. CRIPPS*

HIGH above the icy waters of the Hudson river workmen are now spinning the steel wire cables from which will be suspended the roadway of the huge bridge which will soon connect the states of New York and New Jersey. Going about their appointed tasks like human spiders, these fearless men, indifferent in the face of danger made doubly dangerous by the ice on the catwalks, guide the spinning wheel as it weaves its way back and forth across the river, seize the individual wires, and clamp them into place at proper intervals. Day after day for a year the wires will be spun from the Palisades to Riverside Drive and back again without cessation until the 105,896 wires are strung into place.

In a previous article (December, 1929, SCIENTIFIC AMERICAN.--*Editor*) the preliminary work attendant upon the erection of the main cables was described. That article ended with the stringing of the catwalk suspender ropes. After these ropes were in position it was necessary to install the suspended structure and floors of the catwalks. This work was carried out by the use of carriers which rode upon the ropes, traveling from the top of either tower and loaded with catwalk sections. The carrier was lowered to the center of the span by means of a motor driven windlass; and, starting from the center, the catwalk sections were placed in position one by one.

The catwalks on the back, or end, spans between the towers and the anchorages, have been made in a series of steps with landings, because of the steep angle of the cables in these positions and the hazard to the men.



THE SPINNING WHEEL

Two of these work continually on each of the four cables, traveling back and forth across the bridge many times carrying wires that will form the cables

There are two catwalks, or footbridges, each of which is to take care of the spinning of the two cables on a side; each is 25 feet wide, made up of a light steel frame, covered with wood planking. Heavy wire netting is placed over the gaps, not only to lessen danger for the men, but to prevent loss of tools into the river below. In the main span, five crosswalks connect the two catwalks so that workmen may pass from one to the other without the necessity of going up to a tower and crossing over.

In spinning the cables, two batteries or sets of reeling machines, each composed of four reels, are placed on each side of the river so that, altogether, there are 16 reels of wire working simultaneously. Special reels have been constructed from steel channels and boiler plate, each to contain 160,000 feet of wire. These are placed on a freight car near the reeling machines and are then pushed into position and lifted onto the machine by means of an electrical lifting device which centers the reel and allows it to revolve.

To facilitate handling of the wires as they are spun, each cable will be made up into 61 so-called strands of parallel wire, each to contain 434 wires, making the total for each cable 26,474 wires.

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* Of John A. Roebling's Sons Company

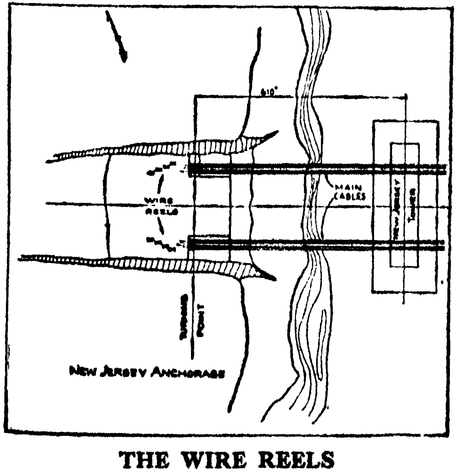
The connecting of the wire strands to the eyebars is made possible by means of steel castings known as strand shoes. These are constructed to hold the 217 loops of wire formed by the 434 wires of each strand. In the strand shoe there is a 10-inch hole through which a pin can be placed so that the whole assembly can be connected to an eyebar.

Four tramway systems have been erected, one for each cable. Each of these consists of an endless rope which passes from one anchorage, over the towers to the other anchorage, around a sheave, and back to the point of origin. These ropes are supported at 200-foot intervals by specially designed sheaves and towers; and in order to overcome any sag of rope between the sheaves, a tension carriage, which exerts a tension on the ropes equivalent to a pull of 12,500 pounds, is incorporated.

As will be explained later, these tramway ropes will move continually across the river like giant traveling belts, the motive power being supplied by an electric motor which allows operation in either direction. Two spinning wheels or sheaves each four feet in diameter are attached diametrically opposite each other on each tramway cable loop; that is, when one wheel is on the New Jersey side of the river the other will be on the New York side.

The preliminary details being complete, the actual work of spinning the cables can begin. By referring to the diagrams captioned "The shuttle and loom," the following explanation will make the principle clear.

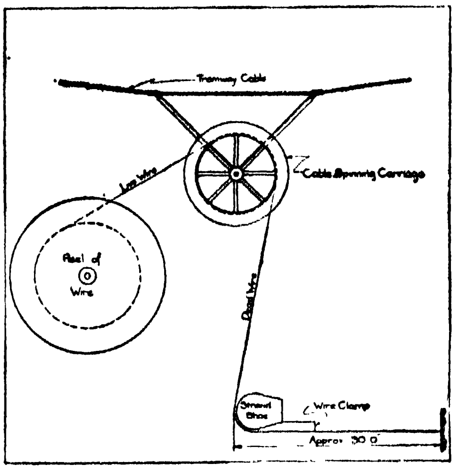
The spinning of the four cables must all be done at the same time so that the weight of the wire placed on the towers—constantly being added to as the wires are pulled across—will be equal at all times. Bearing in mind that the spinning is conducted from both sides of the river simultaneously and that the speed of the reeling machine is synchronized by hydraulic equipment with the speed of the tramway on which the spinning wheels travel, we are ready to begin operations.

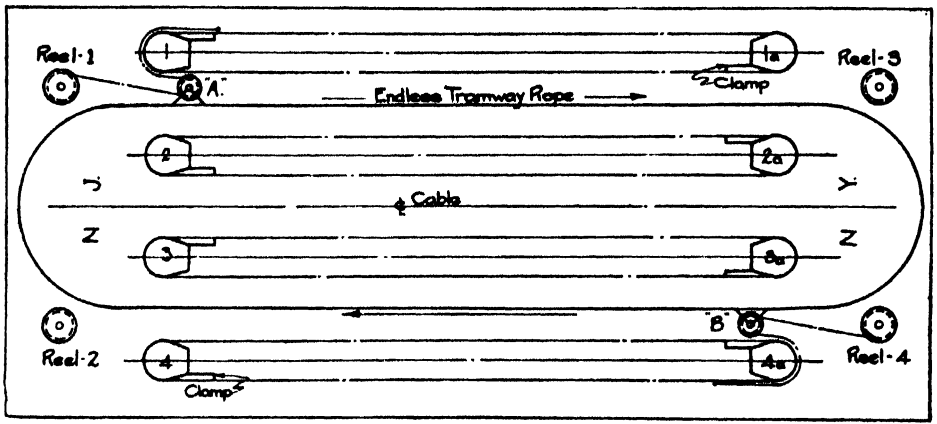


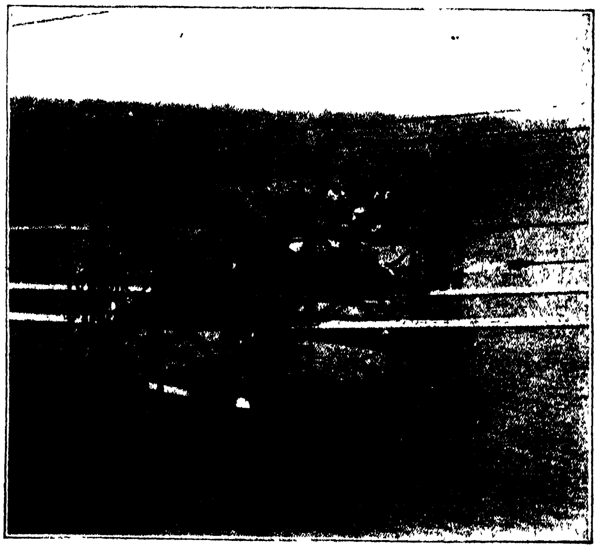
THE WIRE REELS
The New Jersey approach to the bridge, showing location of the reels of wire

For the first trip, which took place October 21, 1929, the end of the wire was taken from reel Number 1 on the New Jersey side, and joined to Number 1 strand shoe (see diagram). The loop thus formed was placed over the "spinning" wheel, or traveling sheave "A" attached to the endless hauling rope or tramway cable. The same procedure was followed on the New York side, a wire being connected to strand shoe Number 4-a and the loop thus formed placed over sheave "B."

THE SHUTTLE AND LOOM
The diagram at the right shows the manner in which a wire is taken off a reel, passed over the spinning wheel, and fastened to the strand shoe. The diagram below, flattened out for easier reading, is described in detail in the text





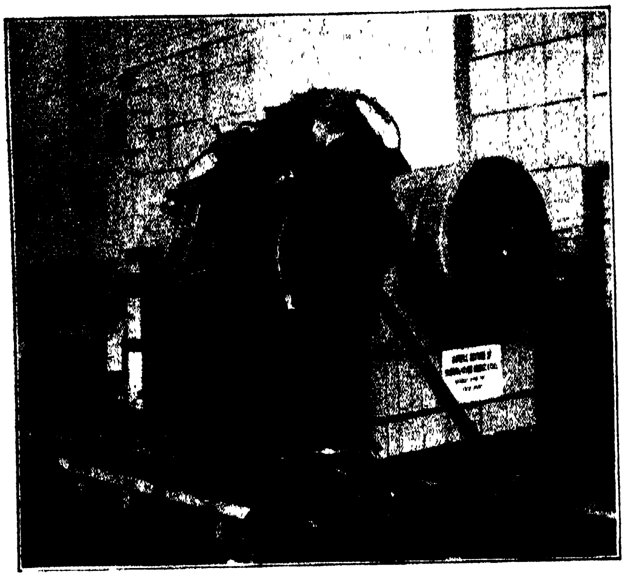


BUILDING THE CATWALK
One of the carriers which were suspended from the catwalk cables and used to construct the walk itself

As the endless rope traveled, sheave "A" with its loop was carried to the New York side, while sheave "B" went over to the New Jersey side. When "A" reached its destination, the loop of wire was taken off and placed on shoe 1-a. At the New York anchorage another loop was then formed from reel Number 3, the end being fastened to strand shoe Number 2-a. Shoe "A" then traveled back to its first position, passing on the way sheave "B," which had performed the same operation on the New Jersey side. The loop taken from reel Number 3 was carried across and placed over strand shoe Number 2, while the loop on sheave "B" which was taken from reel Number 2 was then carried to the New York side and placed on strand shoe 8-a. Each trip of the spinning wheels, the two going in opposite directions at one time, takes approximately 10 minutes.

The stationary wire—that is, the branch of the loop the end of which was attached at the starting point—was successively adjusted behind the spinning wheel so that it hung at a predetermined sag in the first side span and in the main span. After the loop was placed around the strand shoe at the far side, the dead wire was successively adjusted in the last side span, the main span, and the first span. It was then placed around the strand shoe at the point of its beginning, thus forming another loop to be pulled across by the spinning wheel.

This operation will be repeated for each strand until the 217 loops, or



HYDRAULIC JACK PRESS

A sample section of cable the size of the Hudson bridge cables, and the device which will press them to shape

pairs of wires which go to make up the strand, have been placed. On reaching the end of the last loop of the strand, the end of the wire is then connected to the beginning of the first loop. The completed strand thus formed is therefore a continuous length of wire approximately 428 miles long. Instead of returning the wheel empty to its point of origin it is used to pick up a wire loop from a second reel, thus beginning a new strand.

Each spinning wheel travels 209 miles in spinning one strand, or a total of 12,749 miles in spinning each main cable; and, since there are four such cables, there will be an approximate mileage of 50,996 miles traveled by the spinning wheels in fabricating these four cables—a distance comparable to twice around the earth at the equator.

As the strands of each of the four cables are spun, the individual wires are seized and placed in their predetermined positions on the tower saddles. The first strand of each cable is adjusted to the correct deflection and the proper sag is determined by means of precision instruments. The remaining strands are then placed in correct relation to the first as they are spun, and irregularities in length are adjusted by means of shims—thin steel plates—at the strand shoe located at the anchorage.

The above procedure is carried out with each of the strands until the total of 61 which completes one cable is in place. With the full number of strands in place, bunched together, the cross-section of each cable at this stage is hexagonal. It is of interest to learn that the deflection in the center of the span changes about 25 feet during the spinning of these great cables and that the towers compress two inches during the loading.

The next step is the compacting or squeezing of the cables to give them a circular cross-section. This will be done by means of a circular frame in which are mounted in radial formation 12 hydraulic jacks, each of which actuates a concave-faced shoe. This compactor is capable of exerting a pressure of 720 tons although it may be necessary to apply only 300 or 400 tons. The compactor is first applied at the center of the main span encircling the cable, and then half way up each side of the main span. Pressure is then exerted at approximately each 200 feet and finally about every three feet. This method has been decided upon as the best method of preventing "bunching" of the strands at the tower saddles.

While the compactor is squeezing the cable, a wrapping of wires will be made on each side of the compactor in order to hold the cable into its final cylindrical form. This is called "seizing."

From this point, cable bands of cast steel will be placed at regular intervals along the length of the main cables to carry the suspender ropes. (These suspender ropes will be cut from the ropes which now carry the catwalks.) After the cable bands are in place, the suspender ropes will be fitted to them by means of special bridge connections. These ropes will support the roadway susperstructure.

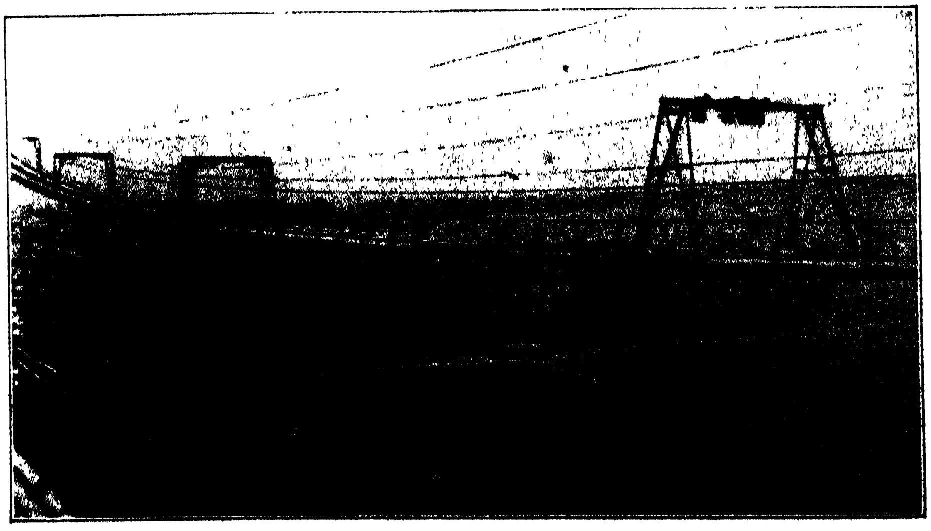
When part of the dead load of the superstructure has been placed on the cables, they will be wrapped concentrically with a soft galvanized wire as a protection againt rust and corrosion. The cables will then be given several coats of paint as a further protection, and everything will be ready for the final touches to be put to the structure.

New methods have been invented by the engineers of the John A. Roebling's Sons Company to speed the spinning of these mammoth cables, and although the system employed in spinning is primarily the same as was used by them on such structures as the Brooklyn and Williamsburg Bridges, later improved methods and design will speed up the work considerably.

This speeding up of the work of spinning is strikingly shown by a comparison of the 21 months' time it took to spin the relatively small cables of the Brooklyn Bridge with the short time of one year which will elapse before the cables are ready to receive the superstructure of that new monument to American engineering ability, the Hudson River Bridge.

COMPLETING THE CATWALK

Wire netting was placed between the sections of catwalks. Note uphill slope



ONE OF THE CROSSWALKS

Five of these walks were installed on the center span of the bridge between the two catwalks. They serve as a convenience for the workmen and to make the temporary structure rigid

Expediting Truck Deliveries

Conveyor Belt Unit on Truck Delivers Load With Ease and Speed

NON-TILTING TRUCK BODY

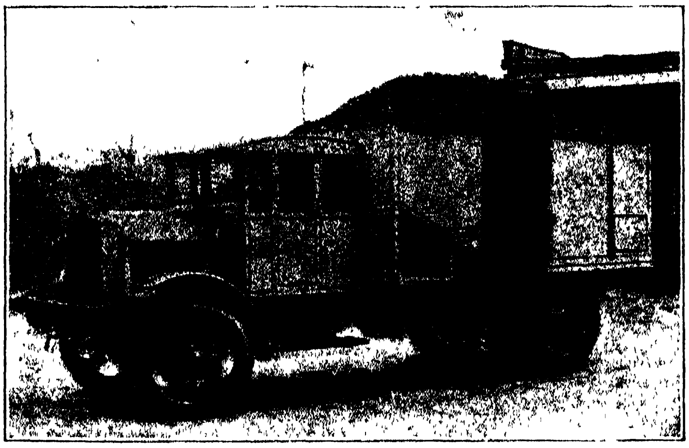
Small truck with floor arranged in rigid position, the conveyor covered

IN present practice, the load in an ordinary motor truck body is dumped by means of a power hoist of some sort, either hand or hydraulically operated. Under favorable circumstances the load may be dumped through a manhole in the pavement and the material placed directly in its storage space or the load is dumped on the ground and recovered by hand and shovel power. In the latter and more usual instance this means an extra handling of the load with the consequent additional expense.

A new self-unloading motor truck body, recently placed in production, is designed so that the material can be placed directly in the storage space. This body is firmly attached to the chassis and arranged with its bottom slanting from each end toward its center. In the center is a conveyor section which, in turn, is connected with a hinged conveyor attached to the body outlet in such a manner that the flow of the material is mechanically forced. The actuating power is derived from the transmission of the truck.

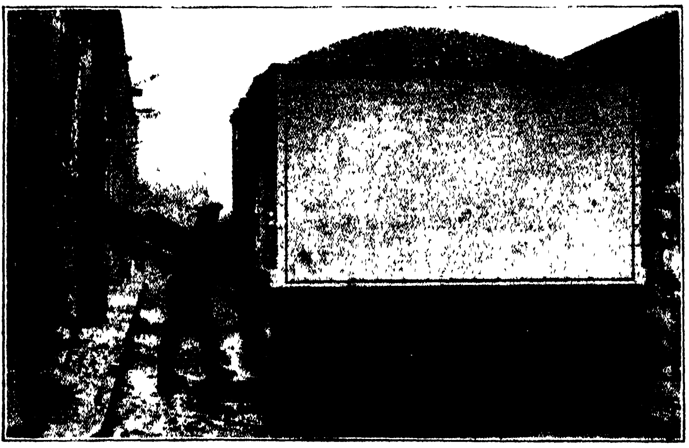
In obtaining this power an additional clutch is necessary and this is governed by a lever in the cab at the right of the emergency brake lever. The clutch is in a housing attached to the main transmission housing. When the lever is moved, the propelling shaft clutch of the vehicle is disengaged and the additional clutch comes into play.

Since the truck body is stationary, the elimination of a hoisting device reduces the dead-weight of the truck by more than a ton without reducing the strength of the body. The bodies are built for any chassis from two and a half tons up to the largest size.



LARGE TRUCK AND ITS CONVEYOR

A 10-ton truck loaded with coal showing how conveyor is carried and the chain-drive method of obtaining power from the transmission



EMPTYING A LOAD "UPHILL"

Unloading 10 tons of coal into a bin, the opening to which is six feet above the ground. The driver regulates the speed of flow

THE DISCHARGE TROUGH

Conveyor for small trucks. It runs length-wise of floor; the sides are sloped

WITH this new device, trucks can be unloaded at a speed of one ton a minute and, under favorable conditions, this speed can be bettered. By using the outlet opposite to the conveyor-equipped outlet and reversing the conveyor section located in the bottom of the body the material can be run off the truck through an ordinary chute into a basement or into a receptacle below the street level, at a rate of two tons a minute. The chauffeur or driver can regulate the flow of material, running it fast or slow as required, as the speed of the apparatus is under his control.

Another advantage is flexibility in delivery. The truck may be placed close beside and parallel to the curb, thus allowing other vehicles to pass on the driveway. In delivering coal there is also the advantage that the coal entrance may be placed at almost any height in the wall, for the conveyor can be raised almost perpendicularly and still place the fuel in the bin with but little slowing up of speed.

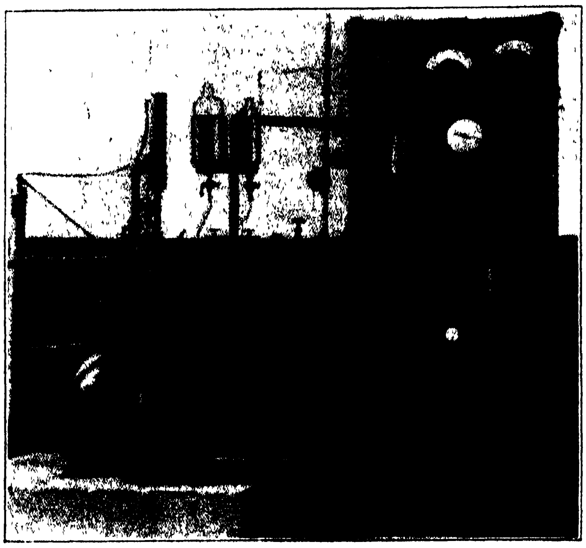
For a chassis under two and a half tons in capacity there has been arranged a modification of the idea just described. This arrangement is called the "all-purpose body" and the conveyor at the bottom of the body is placed to run lengthwise of it. The bottom of the body is raised at the sides, forming a trough through which the conveyor operates and when the body is needed for carrying lumber, ice, or other like material, the sides of the trough can be lowered in less than a minute, making an ordinary truck body available. Material that can be handled by conveyor apparatus can be unloaded from these small bodies at the rate of three tons a minute. The actuating power is also derived from the transmission and can be controlled just as effectively as in the larger bodies described above.

Defeating the Gasoline Knock

Gasoline to Which Tetraethyl Lead Is to Be Added, Must Be Carefully Tested to Insure a Definite Quality

By GRAHAM EDGAR

DURING the last few months thousands of visitors to the General Motors Pier at Atlantic City have paused in front of a shining little gasoline engine mounted under a glass case and connected with various indicating instruments. They have watched levers move automatically and mysteriously, changing the engine's fuel from a red to a colorless one. They have heard the engine begin to "knock," and have seen the indicators register a drop in speed and power as the engine labors. Then again the levers move, the fuel is changed to the red liquid, the knock dies down and disappears, up comes the speed and power, and the engine purrs silently and smoothly. The red fuel contains tetraethyl lead, and the engine and its equipment constitute an automatic demonstration of the effectiveness of this now well known substance in eliminating the knock in an internal combustion engine.



COMMERCIAL KNOCK TESTER

With this small engine and equipment, gasolines are tested. These outfits are now being made and sold

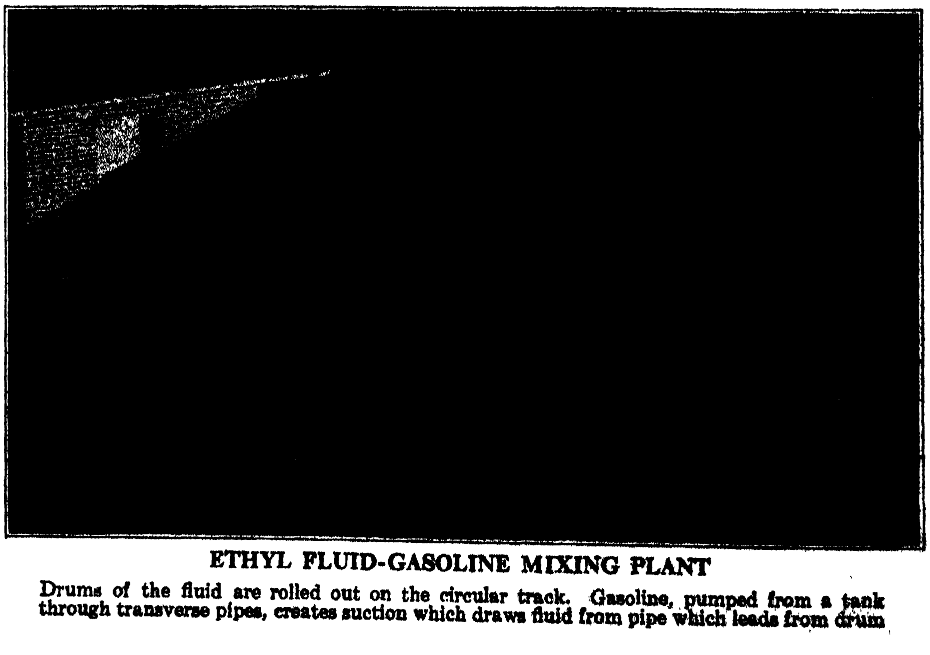
IT is doubtful if many of the visitors who witness the demonstration are at all familiar with the story of tetraethyl lead, or realize how, in a few years' time, this substance has come to play an important rôle in the oil and automotive industry.

The early investigations of the cause of the knock in automobile engines; the discovery that certain chemicals, added to the fuel in small amounts, were capable of eliminating this knock; and the many experiments which led to the discovery, by Thomas Midgley, Jr., of the most effective "anti-knock" known today—tetraethyl lead—would make an interesting story but one much too long for this article. But the developments of the few years which have elapsed since gasoline containing tetraethyl lead was first used commercially are worth a short story of their own.

On February 1, 1923, the Refiners Oil Company placed on sale at a single station in Dayton, Ohio, a new gasoline to which the name of "Ethyl gasoline" had been given. Automobilists who tried the new product, perhaps largely out of curiosity, little knew that the eyes of many engineers were focused upon this particular station, or guessed that the new gasoline was destined to influence profoundly both the oil refiner and the automotive engineer.

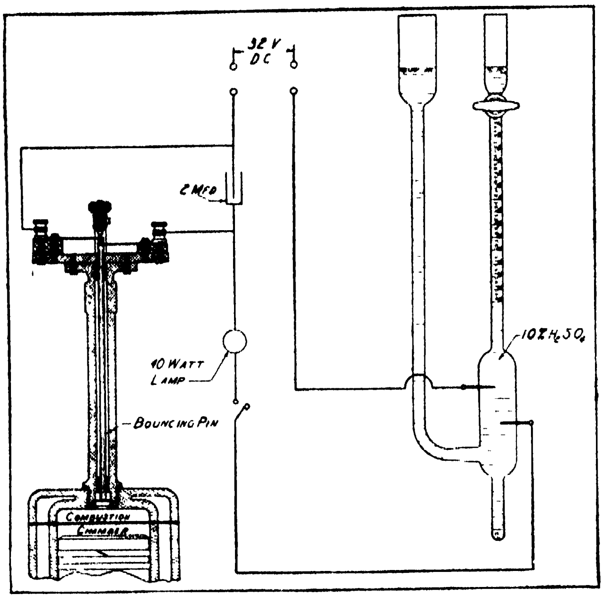
The little station at Dayton prospered, the new product seemed a success. One by one new stations were added, and other oil companies arranged with the General Motors Research Corporation to add tetraethyl lead to their own gasoline. In 1924, the Ethyl Gasoline Corporation was formed, not to sell Ethyl gasoline, but to take charge of the manufacture and distribution of "Ethyl fluid," the blend of tetraethyl lead and other ingredients which, when added to gasoline, converts it into Ethyl gasoline. Since that time one oil refiner after another has added Ethyl to his list of products, and today more than 60 refiners, selling altogether 65 percent of the gasoline used in the United States and Canada, are marketers of the different brands of Ethyl gasoline which the motorist finds throughout the entire country.

BUT the rapid increase in the use of this anti-knock gasoline is only a part of the motorist's debt to the investigators who discovered tetraethyl lead. The discovery of this substance focused the attention of the automotive engineer and the oil refiner upon the knock and its removal, and opened the way for increasing the efficiency of the automobile engine. For it has long been known that the most important factor in limiting the efficiency of the automobile engine is its compression ratio, that is, the ratio of the total volume of the cylinder and cylinder head when the piston is at the bottom of its stroke, to the volume when the piston is at the top of its stroke. The higher this ratio, the more power may be developed when a given amount of fuel is burned. But the knocking tendency of internal combustion engines limits the extent to which the compression ratio can be raised when using ordinary gasoline, for the knock brings with it a drop in power. Tetraethyl lead added to



ETHYL FLUID-GASOLINE MIXING PLANT

Drums of the fluid are rolled out on the circular track. Gasoline, pumped from a tank through transverse pipes, creates suction which draws fluid from pipe which leads from drum



"BOUNCING PIN" DETONATION TEST

Explosion in cylinder bulges diaphragm on which rests a pin; pin is thrown upward, closing an electrical circuit; electricity passes through solution; and gas liberated in burette over period of time measures knock

gasoline limits knocking and permits a higher compression ratio to be employed than could be used without it, thus resulting in increasing the power which a given amount of fuel and a given size engine could produce. And although all such developments must be gradual, it is interesting to note that the average compression ratio of American automobile engines (and hence the efficiency) has increased markedly in the last few years.

Furthermore, the oil refiner has had his attention directed to the anti-knock quality of his gasoline, and by carefully studying the different crude oils which he may have available and selecting the best of them; by developing and employing refining processes which improve the anti-knock value of gasoline; by utilizing tetraethyl lead; or by combining such methods; he has made available for the motorist and the automotive engineer fuels far higher in anti-knock value than any which were available a few years ago.

THIS result, however, has not been achieved without intensive work on the technical aspects of the problem. In the case of Ethyl gasoline, which is produced by blending Ethyl fluid with a wide variety of gasolines, it has been necessary to establish certain definite standards both for the quality—volatility, sulfur, gum, et cetera—of the base gasoline, and for the anti-knock value of the finished product, and to devise a mechanism by which these standards can be maintained by all of the different oil refiners who sell some brand of Ethyl gasoline.

To set these standards is easy; to maintain them is more difficult. The system which has been evolved has necessitated the establishment of a number of laboratories and the close co-operation of these laboratories with the various oil refiners. First there must be a laboratory at Deepwater, New Jersey, where tetraethyl lead is manufactured and blended into Ethyl fluid, and where it is determined that the concentrated product which goes to the oil refiner is uniform in quality.

Then there must be laboratories at strategic points to which the refiner may send samples of the particular gasoline which is to be blended with Ethyl fluid. These samples must be tested accurately to determine just how much tetraethyl lead must be added to them to make them equal in anti-knock value to the set standard. Only when these tests have been made, and the correct amount of anti-knock has been given to the gasoline, is the product ready to be sold as Ethyl gasoline. Finally, a corps of inspectors is continually on the road buying samples of the different brands of Ethyl gasoline and sending them to the nearest laboratory for checking, in order to detect any failure to maintain the standard.

FLOAT-BOWL CARBURETER

Detail of double carbureter which enables shift from one gasoline to another quickly

IN this way the automobilist is protected from the danger of purchasing gasoline below a definite standard of anti-knock value, and the automobile engineer who desires to raise the compression ratio of his engine and thus increase its efficiency knows that at least so far as one commercial fuel is concerned, he can count on its meeting certain anti-knock specifications.

It may be of interest to explain how it is that the laboratory determined how much tetraethyl lead must be added to a given gasoline to give it a definite anti-knock value. The determination is not simple, and the working out of the technique has involved years of study. It has been necessary to develop and build engines specially equipped for the purpose. The engines employed by the Ethyl Gasoline Corporation laboratories (at Yonkers, Detroit, Omaha, and New Orleans) are single-cylinder affairs of very high compression. They are equipped with double carbureters to enable the operator to shift from one fuel to another; and with instruments for recording the intensity of the knock. Naturally, the conditions of the test — speed, temperature, et cetera—must be held very constant. The operator adjusts the engine to a moderate knock on a standard reference fuel, and records the intensity of this knock. He then shifts rapidly to the fuel under investigation and records again the intensity of knock. He then adds tetraethyl lead to the unknown fuel until he finds the knock exactly equal to that of the reference fuel. The double carbureter permits him to shift back and forth from reference standard to unknown until there is no doubt about the result.

But the work of the laboratories is not finished with the production and distribution of a satisfactory product. High compression, like almost any other engineering feature, presents quite definite problems. The most effective type of cylinder head, the location and design of spark plugs, materials for the construction of exhaust valves—these and many other problems have needed study. To promote co-operation between the oil refiner and the automotive engineer, the corporation has established an engineering research laboratory at Detroit which has aided the research organizations of many manufacturers in the solution of their problems. There are other problems also of a more chemical nature. The theoretical aspects of the knock and the action of anti-knocks, the chemical constituents of gasoline and their relation to its anti-knock value, and other allied problems, are being always studied at the research laboratory at Yonkers, New York.

The last few years have seen, therefore, not only a large commercial extension of Ethyl gasoline, but a corresponding technical development, on the one hand helping the automotive engineer and the oil refiner to solve their mutual problems; on the other hand assuring the motorist that his gasoline shall not fall below certain definite standards of quality.

A Memory Trick

At the Cost of An Hour's Intensive Study You May Learn a Mnemonic System Which Will Mystify and Entertain Your Friends. But Memory "Cures" Are Unscientific

By DAVID SPENCE HILL, Ph.D., LL.D.
Member American Psychological Association; late President Southern Society for Philosophy and Psychology; Fellow of the American Association for the Advancement of Science

UNUSUAL happenings like hypnosis, dreams, delirum, appeal invariably to the keen curiosity of human beings. When a charlatan or a "professor of memory" performs in public a seemingly impossible task, interest is quickly aroused. Thousands of persons, after witnessing such a feat, have paid considerable sums of money in order to learn how "to improve their memory."

The fact is, while persons of high intelligence may have excellent memory powers, nevertheless the ability to memorize certain things is not a general mark of intelligence. Cases are on record where imbeciles have been able to do amazing stunts of memory.

1. Air
2. Bar
3. Car
4. Deer
5. Ear
6. Fur
7. Gar
8. Hair
9. Indicator
10. Acorn
11. Ambrosia
12. Arab
13. Arc
14. Almond
15. Ape
16. Aloof
17. Aching
18. Arch
19. Alkali
20. Bun
21. Boa
22. Bib
23. Boric
24. Bed
25. Bee
26. Beef
27. Bug
28. Bunch
29. Biloxi
30. Can
31. Cocoa
32. Cub
33. Comic
34. Card
35. Cane
36. Calf
37. Cog
38. Cash
39. Cacti
40. Dun
41. Dahlia
42. Daub
43. Diabetic
44. Diamond
45. Dice
46. Dwarf
47. Dog
48. Dish
49. Delphi
50. Emulsion

Attempts to invent devices to help defective memories have been frequent since ancient times. In comparatively modern times the Englishman, Pick, aroused excitement in England with his mnemonic systems. Some seventy-five years ago a man named Loisette, afterwards called an imposter, gained momentary respect and fame in Washington, D. C., because of his claim of inventing a valuable mnemonic system.

Everyone uses every day some kind of device to help to remember; for example, numbers on houses, monuments, trademarks. The success of advertising depends not only upon arousing attention but also upon creating lasting impressions. Most high school and college work depends upon successful memorization.

It is not surprising, therefore, that artificial, or formal, mnemonic devices continue to be sold to the unwary. By means of some of them seemingly, amazing things can be done by almost any person of fair intelligence who is willing to devote two or three hours to mastering such a system as the one explained herewith. This was devised by the writer and was built upon the following two psychological principles:

First, whatever we learn must be related to something we know already. This principle is technically called the "doctrine of apperception." Second, thoughts once vividly brought together in consciousness tend to persist. This is the principle of "association."

I. The first nine words of the system shown within the box begin with letters of the alphabet in numerical order. For example, A is No. 1 of alphabet (*A*ir); B is No. 2, (*B*ar); C is No. 3 (*C*ar) and so on. In the first nine mnemonics the final *R* has no particular significance.

II. Final N always represents zero, including and after the tenth mnemonic. For example, 10th mnemonic is Acor*n*, 20th mnemonic is Bu*n*, 30th mnemonic is Ca*n*, 40th is Du*n*, 50th mnemonic is Emulsio*n*.

III. Including and after the tenth mnemonic, for the numerals, either the *initial* or *final* A always stands for 1, B for 2, C for 3, D for 4, E for 5, F for 6, G for 7, H for 8, I for 9, and N for zero. For example the 11th mnemonic is *A*mbrosi*a*; the 20th is *B*u*n*; the 25th is *B*e*e*, and so on.

THE above facts make it easy to fix permanently in mind the whole list of mnemonics, each in its proper number or order. After accomplishing this, then picture with as vivid imagination as possible, what each mnemonic stands for. *Air*, picture, for example, a tank of compressed air; *Bar*, a big iron bar; *Car*, a railroad box-car; *Ear*, your own right ear, and so on through the list, making up your own list of associations. Make each mental picture definite and vivid. About one hour of undisturbed, concentrated study should be sufficient for you to fix in mind this list of mnemonics.

For a first experiment, or test, ask a friend to write and to number, say 25 or 30 names of simple objects, such as floor, tree, dog, clock, flower, house; that is, common nouns, only. Such words are easy to memorize after you have heard them read once, very slowly, with the number of each word spoken as it is read, and after you have pictured each word with a mnemonic in consecutive order.

When the first word has been read (say, "*floor*") immediately imagine strongly, some picture connecting *Air* (mnemonic No. 1) with floor. Perhaps you will visualize "an air tank in the middle of the floor." After definitely forming this mental picture, say "all right" as the signal for the second word to be spoken. Suppose the second word is "*dog*." Thereupon imagine vividly a dog being struck by an iron bar (Bar is mnemonic No. 2). Say "all right" again, and then call for the third word. Whatever it means to you is to be similarly associated with the third mnemonic (Car). This process is to be continued throughout the list.

Afterwards when recalling a word, first ask for its number. Suppose one says "Give number 2." This makes you think of *Bar* (see the table or "system") and *Bar* makes you think of *dog*. Thus you may repeat after one hearing a list of simple names of objects, in any order backward or forward.

To one who does not understand the use of this formal device the performance seems to be wonderful, but it is in reality no more wonderful than facts of every-day experience.

The ability thus acquired to repeat after one slow hearing, in any order requested, a list of simple words is quite startling to the uninitiated, and to be able to do the stunt is to have the means for a surprising amount of fun at a social gathering, or at dinner clubs. The performance, well done, invariably awakens interest.

To illustrate an important psychological principle and for amusement, this mnemonic device is valuable, but it can not increase native capacity, and the use of any formal mnemonic system is cumbersome and awkward in practical life. It is no cure-all for defective memory.

With the Historians of Science

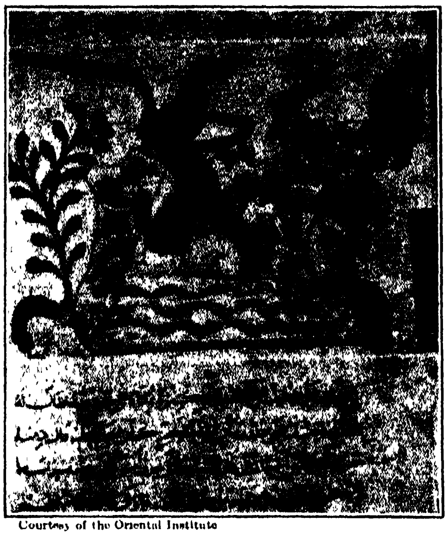
Himera's Doric Temple Being Excavated

HIMERA on the north coast of Sicily is being excavated. The present excavations are being undertaken near the Doric Temple which was dedicated to Minerva. The government is helping by ordering the expropriation of the houses which cover the site. A number of broken columns have been unearthed as well as a great deal of the base, the facings for the walls, the architrave, frieze, and cornice.

Unearthing the History of the Crossroads of East and West

FRENCH archeologists in Syria have made important discoveries at what might be termed the crossroads of East and West on the Mediterranean coast near the old town of Latakieh. In a poor Alawit village a palace of 1300 B.C. was discovered. This is at approximately the period of the Exodus. A vast necropolis with princely tombs was also discovered. These tombs have been plundered, but enough remains to give indications of the religious rites of the builders. A library of tablets was also found which may indicate (when deciphered) the world's first alphabet. It will probably be some time before the experts can identify the letters with sufficient clarity to make up a language.

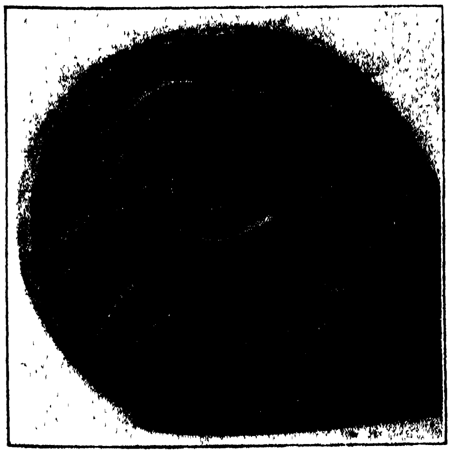
At Katna in the middle Syrian desert, other discoveries have been made. Three towns are built, on one another. In the second town the explorers found a temple to the Goddess Nin-Egal, "Lady Ef Katna," and an inscription identifying the town at Katna, one of the celebrated cities of antiquity. Count du Mesnil found two chapels where sacrifices were made to the bloody Goddess. In large basins of clay were traces of a brownish substance which was sent to Paris where police experts declared it to be bulls' blood at least 4000 years old. Vases and jars have been discovered containing skeletons of children.



Courtesy of the Oriental Institute

BRER RABBIT TRAPS THE LION

Exploits of the rabbit in an Arabic manuscript of the Thirteenth Century, showing the ending Uncle Remus describes



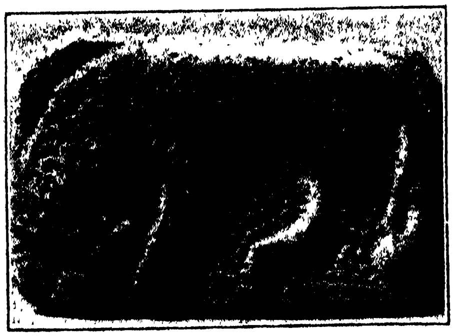
MOHAMMEDAN BATHING PLAQUE

An animal group on the decorated side. The reverse was roughened by adding stone chips before the plaque was fired

An Antecedent of Soap

THE ancients did not use soap, but removed dirt by "erasing." Fortunately we have examples of the scrapers as used by the Greeks and Romans, and now we have examples of the "bathing plaques" of Mesopotamia, 13 of which are in The Metropolitan Museum of Art. We should be inclined to call them "hide scrapers" and their application must have been anything but gentle, for the undecorated, or we should call it the "business" side, was roughened by adding small stone chips before firing. The plaques were probably executed by artist-sculptors rather than potters.

The conquest of Persia, Mesopotamia, Syria, and Asia Minor by the Seljykian Turks, nomads who came from Central Asia in the 11th Century, begins a new era of artistic development of the Mohammedan countries. These bath "stones" are assigned to a period between the 11th and 13th Centuries of the Christian Era.



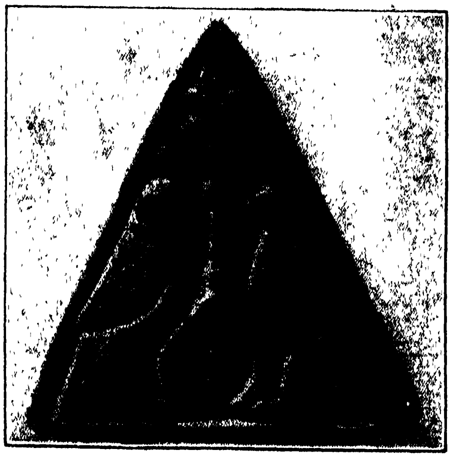
A LION BATHING PLAQUE

This is supposed to illustrate a lion and dates from the Eleventh to the Thirteenth Centuries of the Christian Era

Ancient "Uncle Remus" Stories

THE Oriental Institute of Chicago is engaged in the investigation of an ancient work which, next to the Bible, has become the most widely distributed and translated book in the entire history of literature. This book is of particular interest to Americans, with whom the animal stories of Uncle Remus have become a household treasury. It is quite evident that this body of negro folk-lore contains fundamental elements which have migrated to America from the slave markets of Africa, having crossed the Dark Continent from the eastern to the western coast. Nothing has been easier than for tales of Arabia and even India to reach the east coast of Africa, and in this way they have eventually migrated to the plantations of our own South. Brer Rabbit thus emerges with an ancient oriental ancestry which probably few of our people have suspected.

These animal stories have also reached us by a northern route through England. In 1888 it was calculated that these animal tales had been translated "into 38 languages, in 112 different versions, which have passed into about 180 editions." These various versions are sometimes disguised under the title, the "Fables of Bidpai," or the "Fables of Pilpai." It is of no little interest that the illustrations which we already find embellishing the Egyptian animal tales, should also have been regarded as an essential part of the East Indian cycle. They are quite commonly found in the Arabic versions surviving at the present day, and here we may see Brer Rabbit over the discomfited Lion who is disclosed head downward at the bottom of the well in precisely the same uncomfortable situation into which Uncle Remus tells us Brer Rabbit betrayed him.



THE AFFRONTED BIRDS

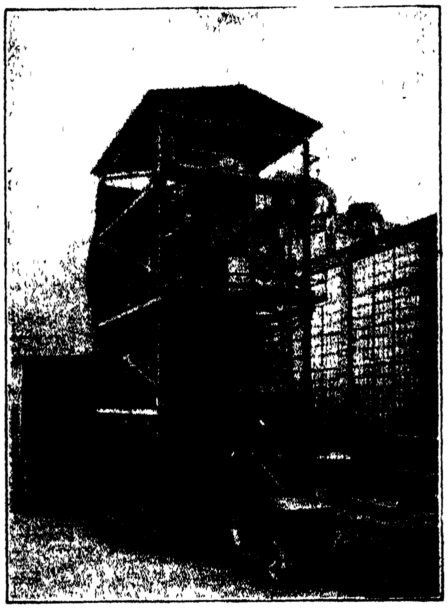
A highly artistic piece from Mesopotamia, modern in treatment. This was found in a public bath where it was originally used

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

A "Ferris Wheel" Car Parking Machine

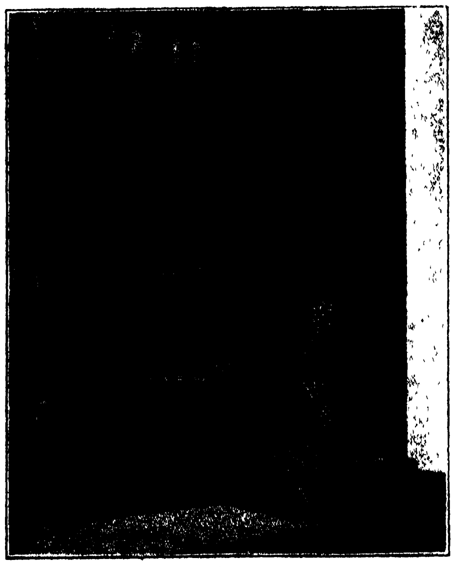
WE have become so accustomed to automatic devices that we expect the pushing of a button to give us any desired result. In our own homes we press a button to turn on the lights or to start a fan. If there is an elevator in the building, we call the car to the landing by operating a button. The immense presses printing our newspapers and magazines are controlled by push buttons, as are many other machines in daily use. It will, therefore, seem reasonable to have a parking place for our automobile where we can call the car to the driveway level by pushing a button.


The experimental car parking machine developed by Westinghouse

This has recently been accomplished by the design of an automatic parking machine, resembling an elongated Ferris wheel, which can be installed in hotels, apartment houses, theaters, department stores, and office buildings as well as in garages. The cars are placed on platform cages suspended between endless chains which pass over wheels at the top and bottom of the building. The chains are operated by an electric motor provided with a push-button controller which will stop the machine when the designated cage is opposite the driveway. When a car is driven on a cage, automatic means are provided for moving another empty cage to the driveway so that the machine is always ready to receive another car. The cars remain on the machine until called for.

The part of the building in which the machine is located has no floors and may be merely an enclosure surrounding the machine or it may be a portion of a building used for other purposes. The machine may be removed at any time and floors placed in the building for other uses. The operation of the machine is quiet so that the ordinary separation walls that would be provided in the building will prevent the sound from being carried through the building. After the machine has been started, its motion is continuous until the specified car has reached the driveway.

A very ingenious arrangement is used to transfer the cars from one side to the other at the top and bottom of the building. This consists in carrying the car on an arm that extends from the side of the chain. During the vertical motion the cage and chain travel at the same speed but at each end of travel, the car moves in a circle having a radius of about double that of the chain. This causes the car to travel at twice the speed of the chain and moves it out of the way of the next car. The arrangement enables ordinary passenger cars to be placed eight feet apart in the vertical position. A building 100 feet high will provide for a 24-car machine which occupies a ground area of approximately 16 feet by 24 feet; this is about the same space that is occupied by an ordinary two-car garage. There is no particular limit to the vertical height of the machine as this will usually be determined by the building limitations and also by the time required to bring the car from the top of the building to the driveway level. The machines which have been constructed have had a chain speed of 100 feet per minute which would bring the car from the top to the bottom of a 100-foot building in one minute. Higher speeds can be used where the conditions make it desirable to do so.


Manner in which the car parking machine is built into a building

Giant Hog Was Big as Auto

THE fossil skeleton of a giant hog which stood seven feet tall has just been mounted in Morrell Hall at the University of Nebraska. The terrible pig in his prehistoric day was as high as the tallest modern automobile and had a "wheel base" of about 140 inches.

The fossil was dug up in Sioux County, Nebraska. Only two of the giants have ever been discovered, the other being smaller than the university's specimen. The pig, scientifically termed *Dinohyus hollandi*, lived during the late Oligocene or the early Miocene age, which would give him an antiquity of some 12,000,000 years.—*Science Service.*

Cape-to-Cairo Highway Improved

IN the article "Pioneering for a Cape-to-Cairo Highway" which was published in our August issue, the author, Mr. Gerry Bouwer, made the statement that, "northward from Bulawayo there was nothing but dense African forest with only native paths for a road . . ." Mr. E. J. Hutton-Brown, Superintendent of the Southern Rhodesia Publicity Bureau, apprehensive lest this statement deter tourists who contemplate a visit to Southern Rhodesia by road, calls attention to the fact that the highway has been considerably improved since Mr. Bouwer's trips. To prevent any misconception as to the present state of the highway in question, we publish below a part of Mr. Hutton-Brown's letter:

"For the past 12 months the road from the Transvaal border, that is, from the ford through the Limpopo River to the Victoria Falls via Bulawayo, has been clearly defined and maintained in good order by the Southern Rhodesia Roads Department. The road has been widened out from the original track, and made up wherever bad places occurred. Signposts have been erected at all important deviations, and, when it is stated that approximately 10,000 automobiles used this road for pleasure purposes during the past season, it will be realized that the pristine conditions of which Mr. Bouwer wrote, no longer exist.

"A tour by road to the Victoria Falls during the correct season, that is, from May 1 to September 30, has become deservedly popular with every visitor to

Car parking tower, an independent invention which is operated on practically the same principle as the one described and illustrated above. It was invented by Mr. J. E. Morton of Sandusky, Ohio

South Africa from overseas, and visitors do not consider their arrangements are complete unless they include this wonderful trip through some of the most magnificent of Southern Rhodesia's forest scenery. Furthermore, since Mr. Bouwer passed through, the Victoria Falls Hotel, situated on the edge of nature's most mighty masterpiece, has been renovated and enlarged, and now provides accommodation and attention for travelers which is amazing, considering its far-flung position.

"At the beginning of the month of August an ornate high level road and railway bridge, over 1500 feet in length, spanning the Limpopo River, was opened for . . . tourists traffic, so that there is no longer any necessity for automobiles to be towed across the river as is depicted in the photograph accompanying Mr. Bouwer's article."

"Baby" Car for United States Market

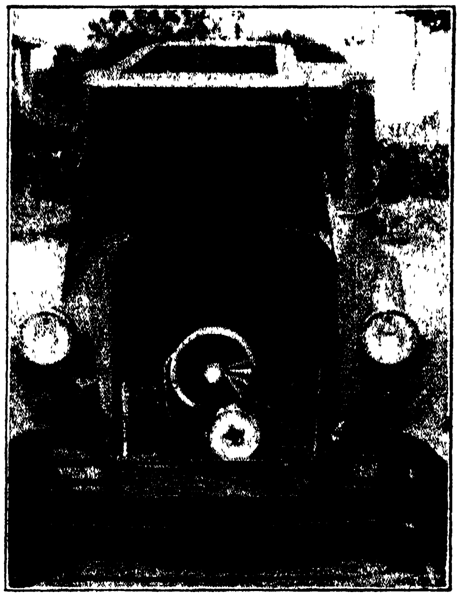
IT has been announced that within the next year a small automobile seating two people comfortably, weighing 600 pounds, and equipped with a four-cylinder air-cooled engine, and with all moving parts, except the engine, greased for the life of the car, will appear on the market in the United States. The car has been designed in its entirety by James V. Martin of Garden City, Long Island, who is well known in the aviation field; in fact the car itself is an outgrowth of Mr. Martin's experimental work in aviation.

The photographs give some idea of the construction of this tiny car which has no chassis, the body frame serving as the support for the suspension for the front and rear ends. There are no springs, the wheels being separately suspended by means of rubber shock-absorber cords such as are employed in many types of airplanes. This suspension allows each wheel to work independently of the other three and reduces the "unsprung" weight to a minimum. It is claimed that these shock-absorber cords will function perfectly for 25,000 miles of operation and that they can be replaced by anyone quickly and at a very low cost.

In the rear end there is a universal joint on each side of the differential and another in each wheel. Because of this construction, power can be transmitted directly to the wheels without any axle housing. The wheels are suspended with the shock-absorber cord and work independently of any other part of the car; in fact the differential is fastened rigidly to the underpart of the body.

This little car has a wheel-base of only 60 inches and uses small rubber tires, yet in a demonstration given to the writer of this item, the car held the road perfectly at 60 miles per hour and was as comfortable as a much larger and heavier car. During the demonstration, the automobile was driven over a rough plowed field with an absolute absence of the racking rebound which would be found under the same conditions with a car suspended by ordinary springs.

Detail of the airplane shock-absorber cord mounting of a wheel of the "baby" car. The wheel spindle rides on a vertical shaft enclosed in a leather dust protector. The entire weight of the car rests on the rubber cord, being suspended from the wheel spindle



Front view of small car with cowl in place on the air-cooled motor

A view of one of the experimental models of the "baby" car, with the hood raised, showing the motor with the air-current-directing cowl removed to show the fan and the cylinder heads. At the extreme left of the photograph may be seen one of the separately suspended wheels shown in detail above

It is intended to sell this small car at about 200 dollars including a large waterproof packing case which may be used as a garage for housing the car. At the present time, however, plans for production have not matured and it is impossible to state when these small cars will be available to the general public.

The present plans and specifications call for an electric starter or a mechanical starter operated by foot pressure, a gasoline tank mounted under the cowl, a standard 3-speed and reverse selective gear shift, a 4-cylinder air-cooled motor equipped with a large fan, disk wheels of new ribbed construction, and a two-passenger body in which there is more than ample leg room for both driver and passenger.

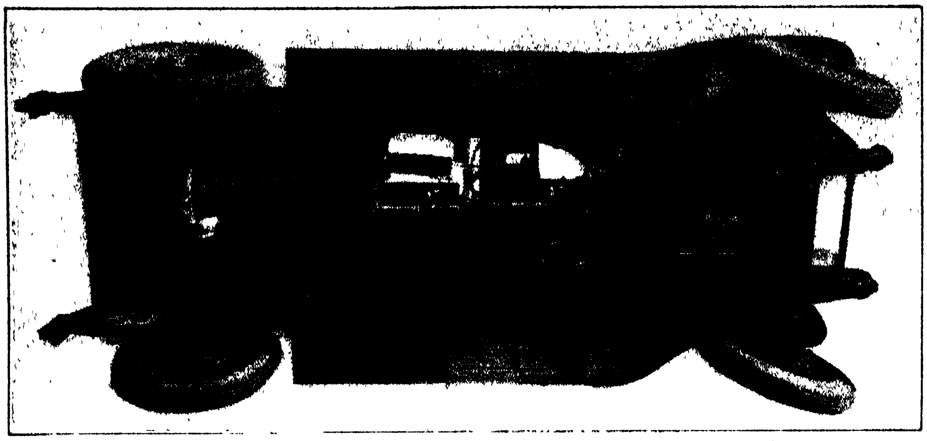
Japanese Navy Correction

IN Dr. Oscar Parkes' illuminating discussion of the newly built ships of the Japanese navy appearing in our November, 1929, issue, a typographical error occured in giving the dimensions of the cruiser *Nachi*. She was quoted as having a draft of 86½ feet whereas this should have been 16½ feet. Please make this correction in your file copy of the issue.

A High-Speed Gasoline-Electric Automobile

A NEW type pleasure automobile with no clutch or gears to shift, and capable of quick pick up and fast speed on the hills—a combination 60 horsepower gasoline and electric car—has been delivered to Colonel E. H. R. Green, son of the late Hetty Green, world's richest woman, at his South Dartmouth, Massachusetts, estate. It is the first automobile of its kind ever built, and is the result of combined experimental work by engineers of the General Electric Company and the Rauch and Lang Corporation of Massachusetts.

In external appearances it looks just like any gasoline driven car, except for a windshield double the average height. This was made especially for Colonel Green so that when the top is raised he may get in and out of the car without stooping over. The real difference is in the mechanism under the floor boards and in the controls. There



View underneath a Willys-Knight chassis equipped with electric drive. The generator is directly behind the engine and the motor behind the generator

are but two foot pedals, one for the brake and one for the gas. The clutch pedal and the gear-shift rod, or lever, to the right of the driver in ordinary cars, are eliminated. The emergency brake to the left of the driver and the starting button to the far right are the same as in other cars.

In addition to the absence of the clutch and gear shift, other features of the new car are that it is impossible to stall the engine without actually shutting off the ignition and it is impossible to start with a jerk. Even though the accelerator pedal is jammed down to the floor board, the pick-up will be gradual and smooth because of the automatic electric equipment. There is also an outstanding safety feature, for the driver can keep both hands on the wheel and his eyes on the road at all times after the car has once started to move. When the car is brought to a stop, the idling of the gas engine is not sufficient to cause the generator to generate enough electricity to turn the motor. All that is required to get the car under way again is to remove the foot from the brake pedal and step on the gas. The more gas, the faster the speed.

This particular car for Colonel Green is geared to make 40 miles an hour. However, by changing the gear ratio on the rear axle, it can be made to operate at speeds comparable with gas driven cars, according to engineers of the General Electric Company.

The electric generator is mounted directly on the fly wheel housing of the gas engine, the generator armature revolving at exactly the same speed as the engine. A few inches back on the generator, or approximately under the front seat, is the electric motor, connected by cable to the generator and coupled by a short drive shaft to the rear axle. As the generator is speeded up, more electricity is fed to the motor, and as the motor picks up, so does the speed of the car. To reverse the car, a small lever is moved, reversing the operation of the motor.

As the motor operates at high speed, the gear ratio on the rear axle was made a worm drive of from 8¼ to 1, instead of the standard $4\,^7/_{16}$ to 1 gear reduction for cars of this type.

On its arrival at Round Hill, his South Dartmouth estate, Colonel Green insisted on taking the steering wheel himself and for the first time in his life, drove a gasoline operated automobile. Although he now has 25 cars of various types and makes, he has never been able to manipulate the clutch pedal and gear shift and heretofore has used a small electric storage-battery car in his daily drives about his estate.

Colonel Green has ordered a second car of this type with a limousine body and is planning a third, of the touring car type in which the driver will occupy an elevated seat in the rear, for use at his Miami, Florida, winter estate.

Truck Removes Cellar Ashes Pneumatically

THE cellar ash-can is facing extermination. Ashes can now be removed expeditiously and economically, with a minimum of labor and with no diffusion of dust, by an electric-pneumatic suction system through a pipe-line from sidewalk to ash-pit.

Ventilating fan and sectional air filter screens of the pneumatic ash conveyor system for trucks

The equipment comprises an ash-handling truck containing a large hopper into which the ashes are drawn by suction, and from which they are conveyed by a totally enclosed belt-conveyor to a carrier-truck which takes them away.

The ash-handling truck is equipped with the gas-electric drive now in wide use for heavier vehicles and already introduced for automobiles of the ordinary type. Power for operating the suction system and the conveyor-belt is obtained by connecting the electric generator to the proper motor and running the engine at suitable speed while the truck is parked.

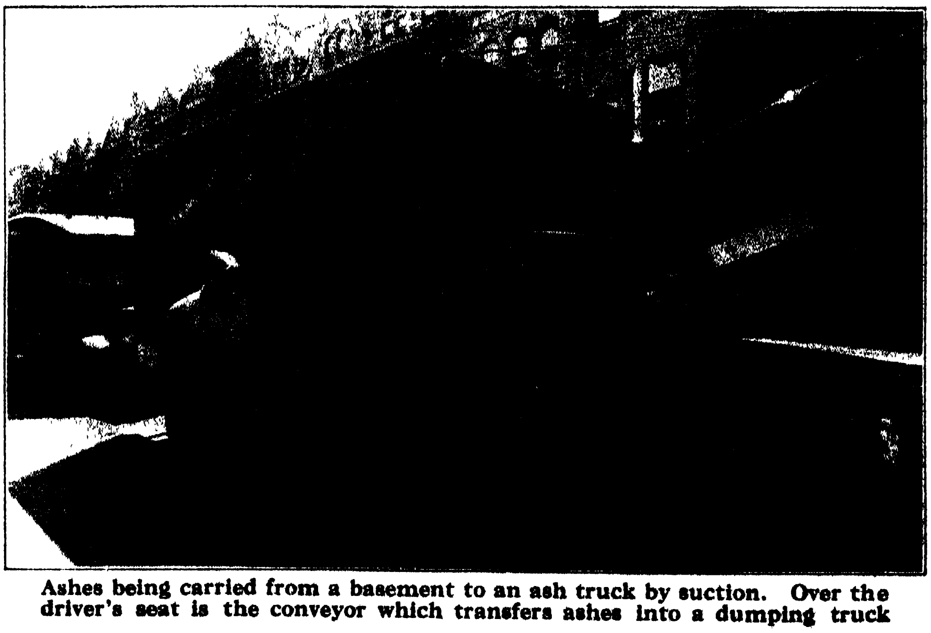
The first of these new ash-handling trucks has been put in service in New York City by the Pneumatic Conveyors Corporation. It was designed and built by the American Car and Foundry Motors Company, and was electrically equipped by the General Electric Company.

Suction is provided by a centrifugal compressor, rated at 6000 cubic feet per minute at a speed of 3500 revolutions per minute and driven by a 40-horsepower motor. The truck is equipped with piping capacity permitting a suction of 2800 cubic feet per minute, equivalent to a velocity of 145 feet per second in the intake pipe. This means that ashes equivalent to the contents of a dozen standard ash-cans can be drawn up every minute to a distance of 30 feet.

Later there will be undertaken the design of a smaller unit, provided with a flexible pipe-line, which can be used for removing ashes from the cellars of residences. The present unit, intended for large buildings, is equipped with a permanent rigid pipe-line extending from sidewalk to ash-pit.

The conveyor truck connects to this pipe-line at the sidewalk opening by means of a pipe section attached to the truck and connecting to the hopper. This pipe section is lowered into place and tightly connected at the sidewalk with the permanent pipe-line so that no dust escapes to the outside air at any point.

In addition to the removal of ashes from cellars, the pneumatic conveyor truck can function with efficiency and economy in unloading coal barges. In that field of application it is expected the truck will prove as useful in proportion as in the elimination of ash-can handling and dust-

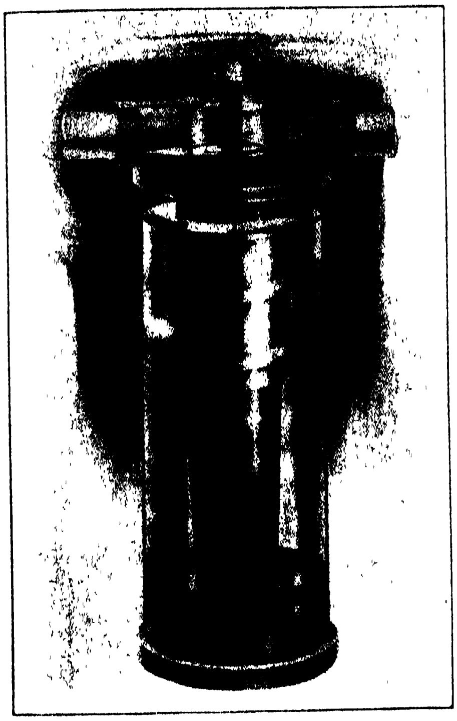


Ashes being carried from a basement to an ash truck by suction. Over the driver's seat is the conveyor which transfers ashes into a dumping truck

filled air which are now aggravating accompaniments of the removal of ashes from cellars in cities and towns.

Centrifugal Separator of Water and Gasoline

WHEN you buzz along the road in your car and water gets into the carburetor—you coast along and stop. But when water gets into the gas of an airplane, the plane is apt to stop quickly—meaning a forced landing or, as sometimes happens, a serious crack-up.



The device that separates water from gasoline by a swirling action

To assure water-free gas, every Bowser aviation fueling pit is equipped with a centrifugal water separator like that illustrated. Gasoline flowing into it is forcefully swirled and the water, being heavier than the gasoline, is thrown to the outside and trapped in the water chamber, which can be emptied periodically. The action is similar to that used in cream separators for separating cream from milk. As a further protection, the storage tanks of Bowser systems may be equipped with a float-suction which removes the topmost liquid first, and all are equipped with several fine-mesh strainers for removing sediment and dirt from the gasoline.

Unbreakable Truck Tail-light

INVESTIGATION has shown that truck fleet owners as a rule do not know how much the tail-light problem costs them a year because it is not generally accounted for under one heading. But if those who do not know will add up the costs of tail lamps, material, time lost on lamp replacements, time lost on summonses, liability damage suits due to no tail-light for a single year, they will find the total is much greater than it should be.

Many of these vehicles resort to the old barn lantern for a tail light. The barn lantern detracts from the appearance of any modern vehicle, is a makeshift, is a considerable fire risk, and as most users know is easily broken.

A new unbreakable tail-light called the Bull lamp, and manufactured by the Champion Rubber Lamp Company of New York City, is made especially for trucks, commercial vehicles, trailers and tractors. These vehicles find it impossible to keep the ordinary pleasure-car tail lamp in commission, due to collision, impact, and vibration.

The Bull lamp is made entirely of rubber, the lens of a special unbreakable compound, and the electric bulb is suspended and protected so that vibration does not affect it. The lamp and fittings are rugged and when properly attached to a vehicle cannot be sheared off. It is easily and quickly attached to any vehicle.

Hydraulic Shock Absorber Installed at an Angle

THE ups and downs of automobiling are not the only jouncing discomforts that a motorist experiences. Starting jerks—braking—sudden stops—sideway lurching—these also exist.

For six years past, a radically simplified type of shock-control device has been going through its test paces. Conceived by a staff of engineers who recognized the magnitude of the problem, this new-type shock absorber was subjected to many tests—laboratory tests far exaggerating the conditions of the road—and tests on the road that attempted to break down the laboratory result. It has been placed on the market under the name of Hydraulicator.

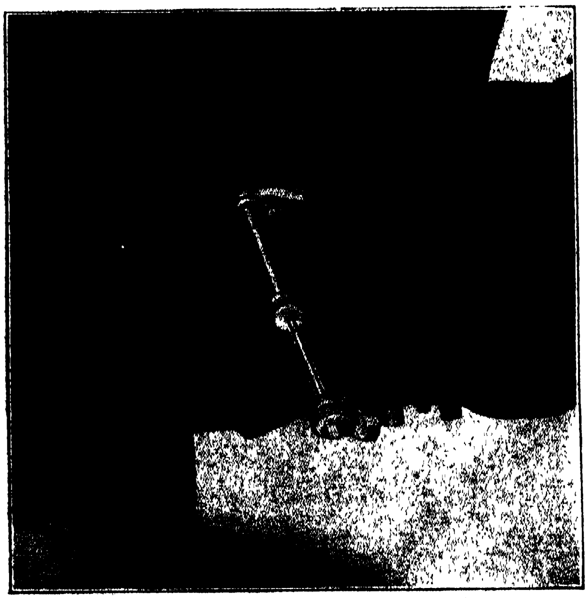
The truck rear-end bumps into a platform but tail light is unharmed

In distinct variance to all former methods of installation, the Hydraulicator is not installed in true vertical position. The rear axle units are inclined forward; the front axle units inward—a revolutionary method of installation that provides efficient, all-angle shock control.

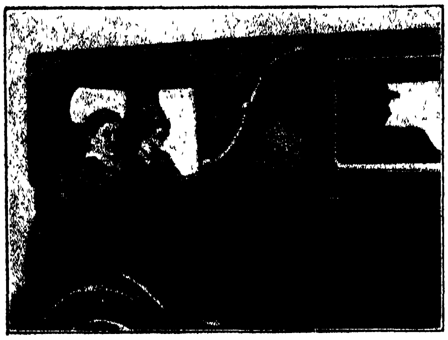
Angular installation eliminates "shimmy." In tests on a well-known car that "shimmied" excessively at only 25 miles per hour, the angular installation of Hydraulicators eliminated the condition entirely, even at excessive speeds for a car of this light type and short wheel-base. Hydraulicators are claimed to prevent "bottoming" of the springs. The new shock absorber cushions the shock in a full half-pint of fluid, every drop of which is in constant, active use.

The Hydraulicator is a simple unit of cylinder and piston. The piston is provided with ports or by-passes to permit the passage of the piston through the fluid. When the unit is mounted between the chassis frame and axle of a car, the resistance created by the passage of the fluid through

The hydraulic shock absorber is mounted at an angle to both the vertical and horizontal, on the front axle beam of a car



On the rear end of a car, the shock absorber takes angles different from those on front



The new rumble seat cover

the ports is proportioned to control the spring action to any desired degree.

Although the unit is a two-way device, the resistance offered is not the same on the up, or compression stroke of the spring, as on the down, or recoil stroke. On the compression stroke a comparatively small amount of check is provided, just enough to prevent the spring from compressing too quickly and "bottoming" on the frame. On the other hand, in order to get riding comfort, the rebound stroke is retarded to the point where the shock is absorbed

Instead of the customary valves, springs, tubes, et cetera, the piston assembly of the unit is composed of three parts: a piston, a flat steel check washer, and a flanged sleeve. The piston moves or "floats" on the sleeve. On the compression stroke, the pressure of the fluid forces the piston down against the flange of the sleeve, shutting off a predetermined portion of the piston ports. On the rebound, the piston is forced up against the check washer, shutting off a greater portion of the ports, and creating a correspondingly greater amount of check.

A Cover for the Rumble Seat

THERE has long been a demand for a practical top for automobile rumble seats. One recently placed on the market fits any roadster or sports coupé. It can be put up or removed in a few minutes without the aid of tools, and anyone can install it. It affords protection from rain, snow, sleet, wind, or cold, and makes the rumble seat comfortable when the rays of the sun are merciless. "Rumbletop," as the new detachable top is called, can be folded into its small container and stored in a corner of the car when not needed. It can be quickly set up as soon as the weather threatens. There are no screws or bolts to drive into the body.

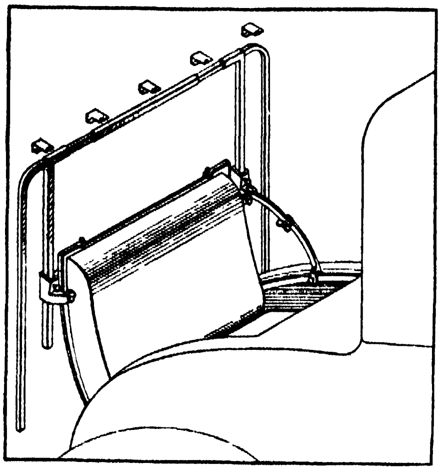
Side curtains are available, if desired, thus affording complete protection against cold weather. The occupants of the rumble seat can get in and out when the top is in place. A pull on the "zipper" underneath the top folds it back, making entrance or exit very convenient.

"Stop-Go" Lights Operated by Car Passing Over Pavement

A MECHANICAL device to direct the movement of traffic in exactly the same manner that a human being would direct it—a device with mechanical senses equivalent to human eyes and a mechanical brain capable of "thinking," "remembering," and of giving orders—has been perfected by the Automatic Signal Corporation of New Haven, Connecticut.

Perhaps the fundamental difference between the corporation's Electro-matic system and the stop-and-go light systems now in use may best be shown by a comparison of the two with the traffic policeman. In every respect the present stop-and-go lights are similar to a traffic policeman sent on duty at an intersection, but blindfolded and with instructions to count 30 seconds on one street and then to turn and count 30 seconds on the other streets, constantly and without regard for the flow of traffic. Even though a dozen cars may be waiting on one street and none on the cross street, the blindfolded policeman will still continue to count 30 seconds before permitting the waiting cars to move.

Installation of the Electro-matic system is the equivalent to the removal of the blindfold. The policeman never keeps a line of cars waiting when there is no cross traffic. He signals them to move ahead just as soon as the intersection is clear. He cares for the safety of every vehicle, but also avoids all unnecessary delay.



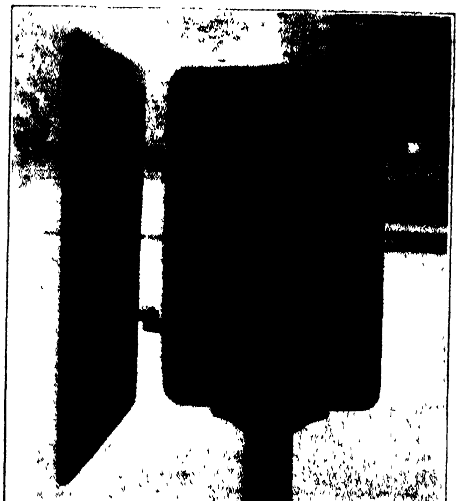
Framework and clips which hold the rumble seat cover in place

With the Electro-matic system, long lines of vehicles receive a continuous right of way. They are never stopped as they are under present automatic systems unless cross traffic actually appears. When opposing traffic does approach, the Electromatic system waits for a break in the line before turning the signal to the cross street. If no break occurs, it waits for a maximum period of time and then stops the line while the cross street vehicles pass. In any case, however, the long line is never kept waiting unnecessarily. At the instant the cross traffic has cleared, whether it consists of one or a dozen cars, the device "remembers" the waiting line and turns to signal it ahead again.

The system consists of three main parts, the most important of which is the control, or "brain" of the system. This is housed in a heavy metal box and is located on one corner of the intersection. Like the human brain, the mechanical brain must have eyes, the second important part of the system. The "eyes" of the Electro-matic system are electrical pressure contacts. These are sunk into the pavement on all streets approaching the intersection, their distance from the corner depending upon the characteristics of the traffic flow at the particular crossing. The third important part is the signal itself, which may be any type of light or signal now in use.

When vehicles pass over the pavement pressure contacts, electrical impulses are flashed over underground cables to the control box. The control then operates the light to meet the exact demands of traffic at the particular moment. The control, however, is capable of more than "seeing" everything that approaches on all sides of it. It is capable of "thinking" and "remembering." Overhead units of a similar type are provided for street cars, and neither snow, rain or ice interfere with their operation.

All of the controls at intersections in the central district of a city may be linked together into a co-ordinated system so that traffic throughout the central area may be moved as expeditiously as it is through a



The street corner control box of the new automatic traffic control

Automobiles passing over the pavement installation outlined in foreground "notify" the control, in center background, which operates lights at right single intersection. When the controls are co-ordinated in this manner, it is possible for traffic on the main arteries to move continuously and uninterrupted by red lights the entire length of the street, regardless of speed. Once past the first light, moving in either direction, vehicles would be able to move without stopping during the entire length of the co-ordinated system. Their speed would not matter. The Electro-matic system is the only one which may be co-ordinated so that traffic will not be forced to move at a fixed rate of speed in order to avoid stops.

Under co-ordination, the controls keep in constant "communication" with each other. The controls at the key intersection at both ends of the main artery telegraph ahead to the next controls the exact number of cars in each block of cars. When the first car in the block reaches the next pavement unit, the light immediately turns green and remains green until the last car has passed. It then turns behind the last car to accommodate cross traffic. This continues until each block of vehicles has passed undelayed.

The controls are exceedingly flexible and are adaptable to any kind of an intersection and to any kind of traffic. They will care for highway traffic as efficiently as city traffic and can be used with equal efficiency at intersections of several streets.

Hydraulic Jacks Installed on Car

DURING the evolution of the automobile from the "one-lunger" of 1900 to the present time, there have been radical improvements in every part of the car with the exception of the method of jacking up the wheels. While automobile jacks have gone through a minor process of refinement, it was not until recently that there was a way to jack up a car without the use of a portable jack.

The development of the Superior four-wheel hydraulic jack provides the first practical method of building into a car a permanent mechanism for raising the wheels. It consists of a set of four hydraulically operated jacks, one for each wheel, to be attached to the axles of the car. The operation of the jacks is controlled from the dash board of the car and each wheel may be raised independently of the others, power for the pumping operation being taken from the engine. The pumping mechanism controls both the raising and the lowering of the jacks. When the jacks are not in operation, they are automatically fastened out of the way and cannot be lowered unless pressure is applied.

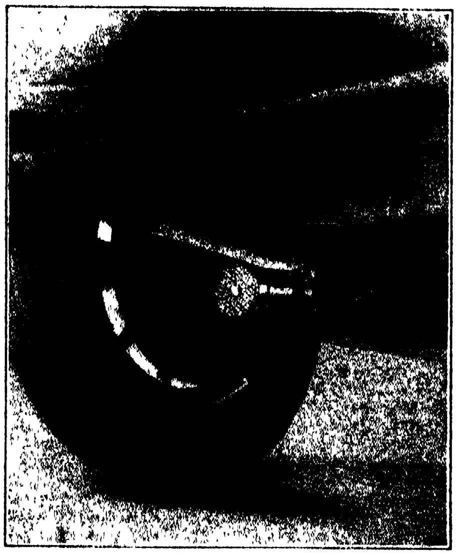
The Superior four-wheel hydraulic jack is not affected by the condition of the road or pavement. The swivel base adapts itself to any angle or surface. The jack is positive in action and will not slip or shift.

The new hydraulic jack can be installed as part of the permanent equipment on pleasure cars, buses, and delivery cars.

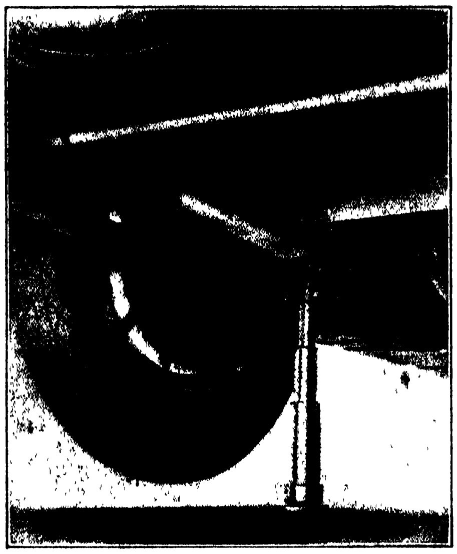
New Type Differential Stops "Spinning Wheel" Evil

A NEW type differential, called the Krohn differential, is said to proportion the engine power to the wheel that can use it and stop the "spinning wheel" evil. It is manufactured by the Krohn Differential Corporation, 209 South La Salle Street, Chicago.

While the device is new to most car owners, many truck operators, and engineers, it is not new in service. It has been successfully used since 1924 and has been quietly distributed to fleet owners who were having trouble making rear-ends stand up in particularly arduous service. This differential, like the conventional type that has been used for years, permits one wheel to turn faster than its mate when rounding a corner. It lets one wheel turn if that wheel is jacked up, but it does not allow one wheel to spin idly, robbing the other of power, when driving on wet paved roads, through mud, or over roads that are slippery with snow and ice.


The permanently installed jack as it is clamped when not in use

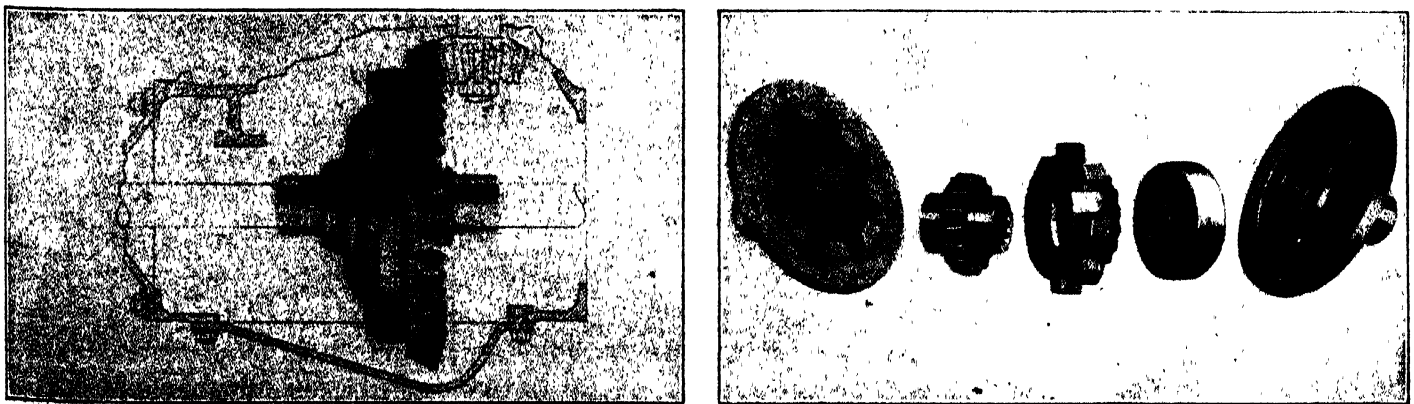
From time to time various specially designed differentials have made their appearance, but these have usually been locking types or intricate mechanisms having more disadvantages than advantages. This new one does not lock. It does not compel the wheels to turn at the same rate of speed, nor is it at all complicated. And while it permits a wheel that is jacked up to turn freely, it utilizes the slightest retardation—even the friction of rubber on wet ice, and employs this resistance to direct the engine power to the wheel having traction.


Hydraulic jack in raised position

The three simple working parts of the Krohn differential are shown in the central part of the illustration. The two halves of the case are at the right and left. A ring gear is mounted on the case, just as with any differential, and the rotation of the case is imparted to the central gear. This, in turn, transmits rotation to the other two gears which are splined on the two drive shafts.

The differential action is obtained, when traction varies, by a difference in the number of teeth in the various gears, which permits the central gear to rotate about the other gears. This allows slight rotation of one driving wheel with respect to the other which is necessary when rounding corners. It does not, however, allow complete freedom of rotation of either driving wheel with respect to the other. And it is this fact which prevents wheel spinning and insures getting power to the wheel that has traction.

In operating a truck, tractor, bus, or pleasure car, this action becomes automatic. The slightest tendency to slip is handled by the Krohn differential before it causes actual slipping. The flow of power is thus constantly directed to the wheel that can use it and the truck becomes seemingly more powerful, shows greater gasoline mileage, and goes up slippery hills and over stretches of ice or snow that could formerly be negotiated only with great difficulty, even with the help of skid chains.


The new differential and its various elements, as described in the text

Learning to Use Our Wings

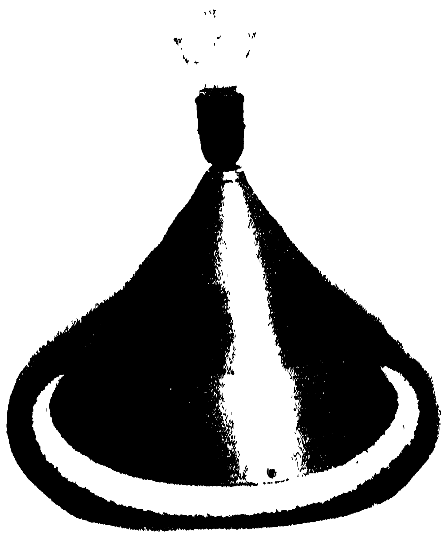
Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

A New Boundary Light

IT is extraordinary how our systems of airport lighting have developed in the last few years, from the primitive methods first used by Army aviators of soaking rags in gasoline and burning them as guides to the incoming pilot. We have now route beacons which guide the pilot to the airport; obstruction lights which mark such hazards as hangars; flood-lights of immense power which illuminate the entire landing area; and finally boundary lights which mark the contour of the field.



Boundary light in working position

The boundary lights, while quite indispensable, offer an element of danger since they must be mounted about ten feet or so above the ground, and may be struck by the plane's undercarriage with disastrous results. The Curtiss-Wright Flying Service is responsible for the construction of a new type of boundary light which avoids this danger.

As shown in our photographs, the new boundary light is supported by a cone which is held in place solely by its own weight. If struck, is overturns easily and disconnects the wiring by pulling a plug through a flexible cable from a weather-proof cut-out. Breaking the contact cuts out one light without affecting other lights on the system. This is a decided improvement over the old system of iron pipe standards.

The Problem of Air-Sickness

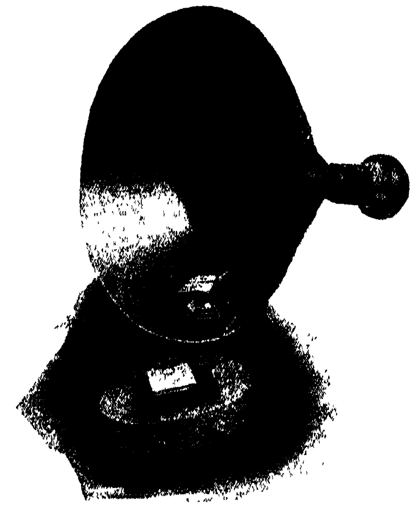
AIR-SICKNESS can be just as unpleasant as sea-sickness and its elimination is a most important problem in air transport.

The Daniel Guggenheim Fund for the Promotion of Aeronautics has therefore done a very useful piece of work by conducting an international inquiry into the subject, consulting American, British, French, German, and Italian authorities, and publishing a survey under the above title, copies of which will be supplied gratis upon application to the offices of the Fund at 598 Madison Avenue, New York City.

There seems to be no doubt that sea-sickness or air-sickness is primarily due to the action of accelerated motion on the labyrinth of the ear, although the exact phenomenon is not yet clearly understood.

There are, however, many contributing causes. One is psychical. A nervous person, expecting to be air-sick, is certain to have his expectation gratified in rough air. The remedy is distraction of the passenger by the provision of interesting instruments in the cabin, maps of the country passed over, et cetera. In the installation of equipment and furnishings in the cabin, attention should not be directed to the possibility of air-sickness. The mere provision of a special receptacle in full view of the passenger may cause his mind to dwell on the possibility of air-sickness, with unpleasant consequences.

Another contributing cause is visual. The airplane should be flown at a fair height, say 2000 feet or more. At such a height a wide view of the landscape is obtained, and there exists a lessened appreciation of the relative movement of the earth and the horizon. Besides, at heights there is always less bumpiness of the air. The passenger should also have a clear and unobstructed view of the horizon, with no window bars, struts or wings in close proximity to the eye. A high-wing monoplane with ample window space is recommended by a British medical officer



New light overturned when struck

Lack of ventilation always results in air-sickness, but noise is also a contributory cause. Opening the windows wide will give a passenger plenty of fresh air, but will also increase the noise and there is thus a serious conflict in requirements. Designers should strive to place the engines as far as possible from the cabin. Special ear defenders are helpful. But perhaps the most important protective measure is the provision of purely artificial ventilation, in which the opening of windows is entirely dispensed with.

Are medicines helpful? Giddiness cannot be fought by drugs, but the "vegetative effects" by which German doctors politely designate nausea can be checked partially by such European preparations as those termed "Vasano," "Nautisan," et cetera.

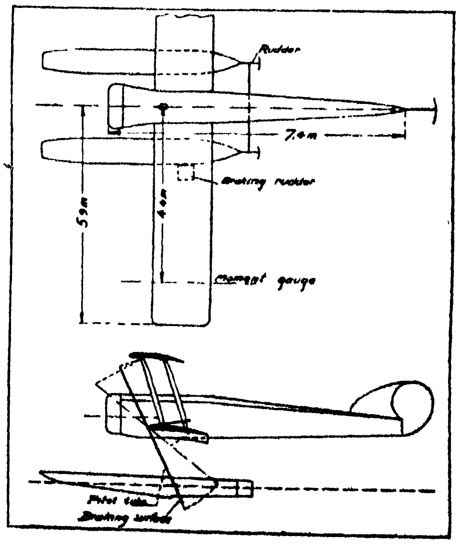
The North German Lloyd employs a further method, known as the Dammert inhalation method. No tablets or powders are involved in this, the medicaments employed being inhaled through a tubular apparatus in a dry and finely diffused state. This is effected by wearing a mask for a period of five to ten minutes. Used on all the North German Lloyd's steamers, this treatment has proved fairly successful. It is not unpleasant and is perfectly harmless.

Problems of Winter Flying

WE understand that it is not uncommon in Sweden for an automobile to be driven out over the ice to a vessel moored in a harbor. Cases are reported of airplanes taking off and landing on frozen waters. Evidently the Swedish aviators also have many winter problems on their hands. One of them is the starting of aircraft engines at low temperatures.

An intensive study of fuels and oils has apparently determined that it is impossible to start an engine at very low temperatures without warming up the engine. With a water-cooled engine a blow lamp applied to the cooling water seems to work out very well. In the air-cooled engine the difficulty is greater. The only practical solution appears to be to warm up the whole engine, a far more difficult job than warming the cooling water only.

With float seaplanes used in Sweden, there arises the problem of being able to land indifferently on water or on snow and



Water rudder and braking rudder used in restricted Swedish waters ice. It is possible to land on snow or ice with ordinary floats, but the wear and tear are prohibitive. The Swedish engineers are experimenting with floats which are elastically mounted and which have elastic bottoms.

While constructors have given much attention to the braking of wheels, they have apparently taken for granted that seaplanes would always have plenty of space to land in. In the narrow Swedish rivers maneuverability becomes more important. Accordingly, water rudders are employed and also braking rudders on the sides of the float. A typical arrangement is shown in our diagrams, by courtesy of the *Royal Aeronautical Society Journal.*

Tailless Light Planes

WE have just received some photographs of low-powered, tailless German planes, which are evidently derivatives of glider practice. While little technical detail is available, these photographs deserve careful study.

The first illustrations show a small two seater, built by Espenlaub, the famous German glider pilot. This plane is equipped with an opposed two-cylinder Bristol Cherub of approximately 20 horsepower, and is provided with a three-wheel landing gear. The main departure from conventional practice lies in the lack of fuselage and tail surfaces

How then is control achieved? The reader will note that the wings have a pronounced sweep-back from their point of attachment at the fuselage. At the tips of the wings there are apparently two hinged rear surfaces on each side. Evidently one pair of these hinged surfaces will act as the conventional ailerons. The other pair, being far back of the center of gravity owing to the sweep-back, will exercise a longitudinal moment about the center of gravity and will act like an elevator. We have therefore both lateral and longitudinal control. Probably also the wing itself has some degree of reverse curvature so as to give fair longitudinal stability while the pronounced sweep-back gives large lateral stability. Apparently the rudder is dispensed with.

In contrast with the conventional airplane, there are, therefore, only two controls instead of three. This involves a novel method of piloting on turns. The pilot banks for a turn with his ailerons, the machine side-slips in the direction of the turn, and the inherent stability of the machine swings it in the right direction and prevents excessive banking. It is plausible to say that the controls have been simplified by the use of only two controls. On the other hand, the control is not so positive as when the three-control system is available. We believe that a greater degree of skill will be necessary with this type than with the conventional plane. On the other hand there are some real advantages.

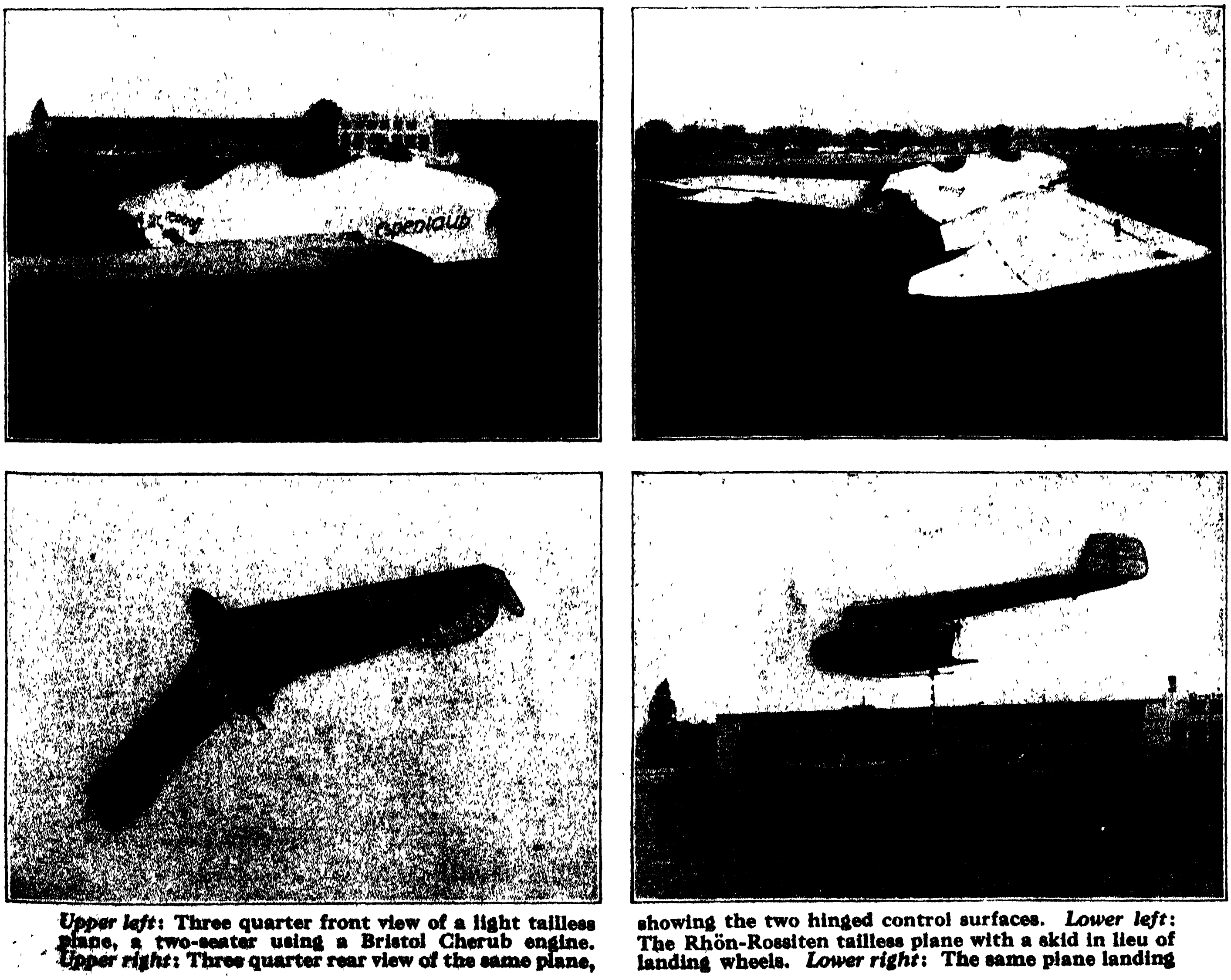
First of all, owing to the absence of the fuselage, there is a decrease in weight and head resistance. Also the cost of the machine is decreased. The use of a three-wheel landing gear is a safeguard against turning over. Therefore, the type has some possibilities for the small sport plane, particularly if a rudder system is added.

Another tailless light plane is built by the Rhön-Rossiten Gesellschaft, the well known German glider association. This is powered with a D.K.W. engine of only eight horsepower; nevertheless it attains a speed of 77 miles per hour. A closed single-seater cabin is employed and simplification as compared with the conventional airplane is carried still further because there is no landing gear — nothing but a skid under the nacelle, with an attachment at its rear end for launching by means of a rubber catapult.

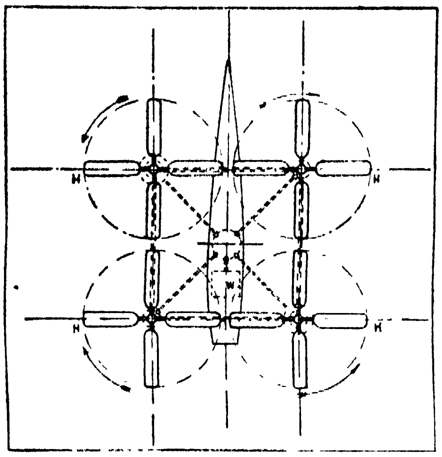
At the tips of the wings are two hinged surfaces, which when moved together evidently serve as an elevator, and when moved separately serve as ailerons. Such independent or simultaneous control is readily achieved by simple mechanical means. At the same time the Rhön-Rossiten light plane is provided with a rudder and fin as can be clearly seen in the photograph, and is therefore a three-axis control machine. The wings are of very high aspect ratio (which shows glider influence) and are braced by external struts.

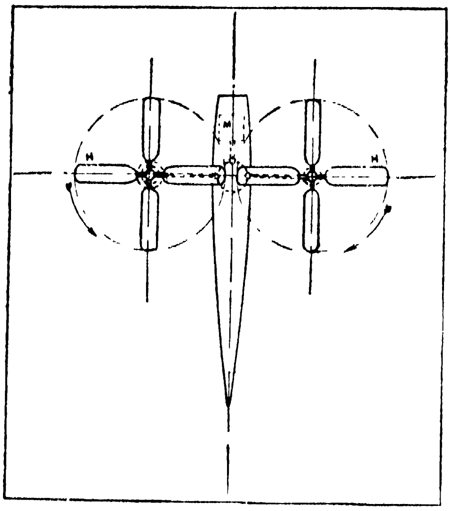
We may add that neither the Espenlaub nor the Rhön-Rossiten tailless planes are novel.

Some time before the war we had the Burgess-Dunne built and flown at Marblehead, Massachusetts, which had similar construction of wings and controls, was ap-



Upper left: Three quarter front view of a light tailless plane, a two-seater using a Bristol Cherub engine. *Upper right:* Three quarter rear view of the same plane, showing the two hinged control surfaces. *Lower left:* The Rhön-Rossiten tailless plane with a skid in lieu of landing wheels. *Lower right:* The same plane landing





Above: **True helicopter, with four lifting screws.** *Below:* **Helicopter with only two lifting screws**

parently promising and was only abandoned because it showed too much instability near the ground, and responded to the action of every gust too readily. In England, Captain Hill's Pterodactyl built two or three years ago, was also based on similar principles and gained much interest.

It is peculiar that these tailless, swept-back wing planes come into the limelight from time to time, fly with apparent success and then disappear. Perhaps the Germans will be more persistent in testing their possibilities to a finish.

Classification of Helicopter Systems

IN our issue of July 1929, we discussed the Isacco helicogyre, now being constructed experimentally under the auspices of the British Air Ministry.

Signor Isacco was led to the invention of the helicogyre by a consideration of the difficulties of the various forms of helicopter. Since the helicopter is of perennial interest, it may be of interest to review the various systems which Isacco studied prior to the design of his own machine, and which he discussed in a paper presented before the Royal Aeronautical Society.

The broad classifications of the direct-lift machine are somewhat as follows:

1. The true helicopter; that is, a craft without fixed sustaining surfaces.
2. The helicopter-airplane, in which lifting screws work in conjunction with fixed airplane surfaces.

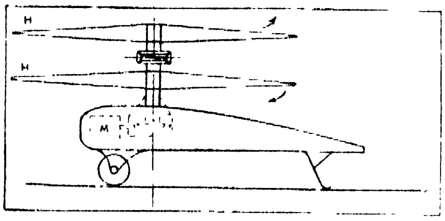
The true helicopter has been built with four lifting airscrews, each on a separate axis. This type is shown diagrammatically. Machines of this type have been built by Breguet and Oehmichen in France, and by De Bothezat in the United States. The airscrews turn, two by two, in opposite directions. The possibilities of such craft at first appear attractive.

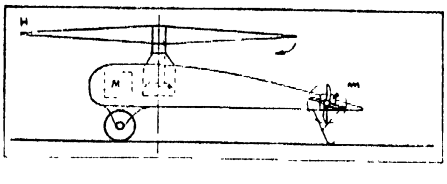
With four airscrews, it is possible to have a large lifting area without excessive propeller dimensions. The airscrews can be arranged to have a longitudinal dihedral; that is, the front screws at an angle to the rear screws, and this, by analogy with the airplane, may be expected to give longitudinal stability. The airscrews can be arranged to have a lateral dihedral; that is the screws on the right side may be placed at an angle to the screws on the left side, thus offering the expectation of lateral stability, again by analogy with the airplane. By providing independent variation of pitch for each screw, it is possible to provide lateral and longitudinal control.

The difficulties of such types in practice are the complications of the mechanical system, excessive weight of the structure, and the fact that such machines will fly in any direction with equal facility. Thus a gust tilting the machine down by the tail may also induce backward motion.

Another variation of the true helicopter is the two-screw machine. Here the mechanical difficulties are somewhat diminished, but there is difficulty in securing longitudinal control in vertical ascent or in hovering.

There have also been helicopters with two screws rotating on the same axis and with one screw mounted above the other. Further simplification is obtained at the expense of stability, (as shown by the test flights of Pescara and others).





Above: **A helicopter with two lifting screws on a single axis, but operating in opposite directions.** *Below:* **A single screw helicopter with auxiliary screw and motor at rear to take up torque of rotation**

Still another line of approach (made by Baumhauer, for example) consists in using a single rotating airscrew and in counteracting the torque of rotation by disposing an auxiliary screw at the rear of the machine. Here again mechanical difficulties intervene.

The combination of a fixed wing surface with lifting screws has been investigated exhaustively by Berliner and is now being tried out by Johnson in Wisconsin. The difficulty is that two principles are confused. The resulting machine is likely to be a poor helicopter or direct-lift machine, and a poor airplane in horizontal flight.

Besides the mechanical troubles, and the dubious stability, the helicopter offers tremendous problems in control under all circumstances and particularly in descent with the engine shut off.

Innumerable patents have been taken out which indicate plausible helicopters on paper. The jump from a patentable idea to a practical helicopter is stupendous.

Modern thought on the helicopter seems to incline away from gearing and transmission. Thus, the La Cierva autogiro employs a huge windmill, driven only by the wind of forward motion. It does not pretend to be a direct-lift machine, but provides very slow landing and a short landing run.

The Curtiss helicopter, now in process of construction, avoids gearing by having a single rotating airscrew which is driven by small engines each operating a propeller and mounted on the large lifting blades, with translation attained by inclining the whole craft.

Isacco provides two or more lifting blades with independent engines driving auxiliary propellers, while a propeller placed at the front end of the machine gives propulsive force.

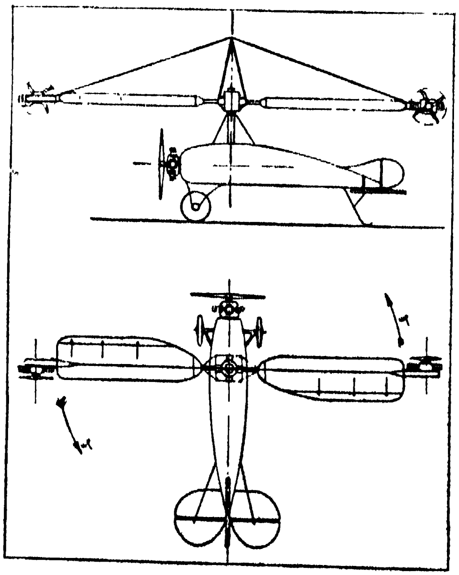
The amount of money, ingenuity, and trouble spent on the helicopter without tangible results is extraordinary. It is one of the mysteries of aeronautics as to whether success will ever be attained.

Black's "Transport Aviation"

IN spite of the rapid growth of air transportation, the number of authoritative texts on the subject remains very small. We therefore welcome the second edition of Black's "Transport Aviation" (published by Simmons-Boardman, New York) which is now a composite work, written by a large number of specialists, including Mr. Black himself, E. L. Jones of the Department of Commerce, Major H C. Biddlecombe of Curtiss-Wright, John C. Leslie of the Aviation Corporation of the Americas, and other authorities. The subjects dealt with are Aviation Law, Air Routes, Traffic Development, Advertising, Safety, Design of Planes, Engines, Airways and Airports, Ground Equipment, Radio Communication, Financial Aspects, et cetera.

It may be of interest to note what the future holds for us, at least in the opinion of the authors:

"The general spread of aviation in the past several years has brought a universal willingness to fly—a condition distinctly



The Isacco helicogyre

differing from that of post-war days. The prejudice against air transport having disappeared, only its high cost is the retarding factor at present. . . . This cost is falling steadily and will continue to fall so far as we can look into the future.

"The railroads will doubtless continue to carry all of the local first-class mail and will be co-ordinated with the air service to act as feeders on the longer hauls.

"It may be set down as a cardinal principle that the railroads or ships or road vehicles have no excuse for carrying mail where it is practical to use aircraft."

The authors also have a prediction to make on the subject of new types of airplanes: "Mail airplanes with facilities for sorting en route, and passenger airplanes with sleeping berths. . . ."

This is a workmanlike, authoritative book, which should be in the library of everyone interested in air transport.

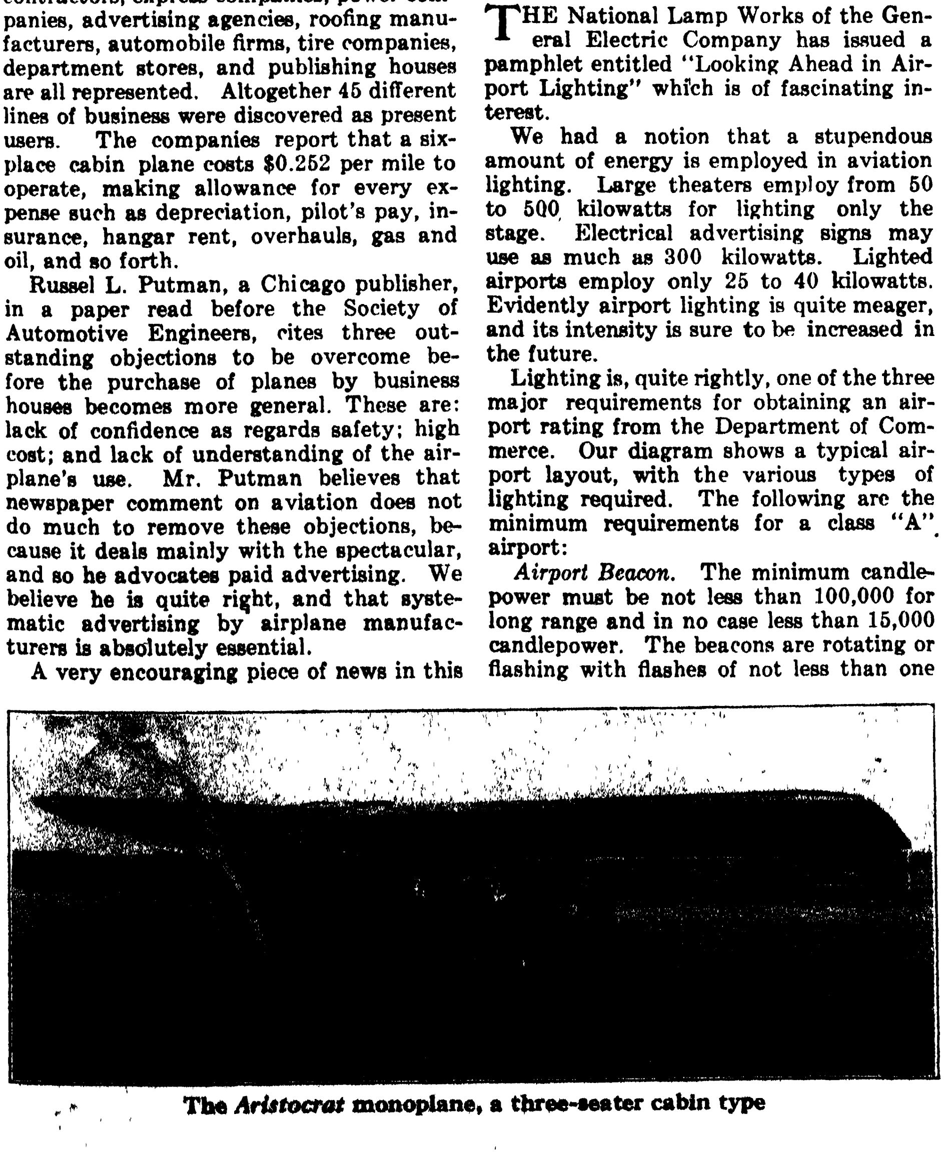
What Businesses Use the Airplane?

AN airplane manufacturing firm, the Ryan Aircraft Corporation, has made a survey of business houses employing the airplane. There are now 135 corporations using planes for their salesmen and executives, for transportation of parts, and so forth The survey shows that four, six, and eight-place cabin planes, powered with single engines are used almost entirely by such corporations. The oil companies are the largest users, but insurance companies, contractors, express companies, power companies, advertising agencies, roofing manufacturers, automobile firms, tire companies, department stores, and publishing houses are all represented. Altogether 45 different lines of business were discovered as present users. The companies report that a six-place cabin plane costs $0.252 per mile to operate, making allowance for every expense such as depreciation, pilot's pay, insurance, hangar rent, overhauls, gas and oil, and so forth.

Russel L. Putman, a Chicago publisher, in a paper read before the Society of Automotive Engineers, cites three outstanding objections to be overcome before the purchase of planes by business houses becomes more general. These are: lack of confidence as regards safety; high cost; and lack of understanding of the airplane's use. Mr. Putman believes that newspaper comment on aviation does not do much to remove these objections, because it deals mainly with the spectacular, and so he advocates paid advertising. We believe he is quite right, and that systematic advertising by airplane manufacturers is absolutely essential.

A very encouraging piece of news in this regard is the purchase of light *Aristocrats* by the General Tire and Rubber Company of Akron. The planes are painted black-and-orange, piloted by Army fliers on leave, and are to make a year's tour of the country. The tour is designed to test the general applicability of the airplane for commercial purposes. Observations are to be made on the effect of weather on all flying, on take-offs and landings in all kinds of fields, and on the wear and tear of landing tires and landing gear. The tour is to cover 50,000 miles and will take the fleet to all parts of North America. It is understood that in the first six weeks of the tour there has not been an hour's delay due to any mechanical trouble with the planes, although there have been engine and carbureter troubles.

The *Aristocrat*, built by the General Airplanes Company, is a likely sort of plane. It has seating capacity for pilot and two passengers in its closed cabin, and a pay load of 476 pounds. Equipped with the Warner engine of 110 horsepower, it has a cruising speed of well over 90 miles per hour when loaded to its full weight of 2000 pounds. As our photograph shows, the *Aristocrat* has the familiar semi-cantilever wing bracing. The landing gear is of entirely cantilever construction, with two solid streamline members on either side. Certainly a trim and comfortable plane such as this should have an appeal to American business.



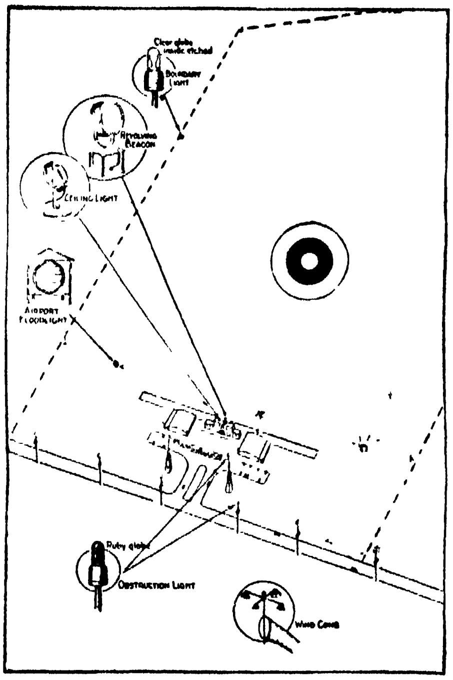
The *Aristocrat* monoplane, a three-seater cabin type

Airport Lighting

THE National Lamp Works of the General Electric Company has issued a pamphlet entitled "Looking Ahead in Airport Lighting" which is of fascinating interest.

We had a notion that a stupendous amount of energy is employed in aviation lighting. Large theaters employ from 50 to 500 kilowatts for lighting only the stage. Electrical advertising signs may use as much as 300 kilowatts. Lighted airports employ only 25 to 40 kilowatts. Evidently airport lighting is quite meager, and its intensity is sure to be increased in the future.

Lighting is, quite rightly, one of the three major requirements for obtaining an airport rating from the Department of Commerce. Our diagram shows a typical airport layout, with the various types of lighting required. The following are the minimum requirements for a class "A" airport:



Minimum lighting facilities required for a class "A" airport

Airport Beacon. The minimum candlepower must be not less than 100,000 for long range and in no case less than 15,000 candlepower. The beacons are rotating or flashing with flashes of not less than one tenth second duration. Light distribution must be visible all around the horizon and to the zenith or nearly so.

Boundary and Obstruction Lights. Either 600-lumen series or 25-watt multiple lamps are employed in clear weather-proof globes mounted on standards 30 inches above the ground, and spaced not more than 300 feet apart to outline boundaries. Green is substituted for white to show the points of best approach, and red globes to show hazardous approaches. The utility of these lights to the incoming aviator is obvious.

Wind Cone and Hangar Lighting. The wind sock, as the wind-direction indicator is called familiarly, must be so lighted as to be visible 1000 feet in all directions if externally floodlighted. The exterior surface of each hangar must be floodlighted to two and one half candles.

Ceiling Light. One of the most useful pieces of airport equipment is the ceiling light, which is projected until a cloud is hit, so that by measurement on the ground of the reflected point, the ceiling or height of the clouds may be determined.

Field Floodlighting. One or more illuminating units are used to provide an even distribution of illumination without shadow areas and of sufficient illumination to make the ground details visible from an altitude of 30 feet. The system must be controlled from a convenient point and be sufficiently flexible to permit landing under all conditions of wind direction without the necessity of landing directly towards the light source.

The care that is evident in the regulations of the Department and in the development work of various airport lighting companies is remarkable.

European Research

THE October *Journal of the Royal Aeronautical Society* contains a number of authoritative papers on the progress of aeronautical research in various European countries.

In France, considerable attention is being paid to the problem of flight on one engine with a twin-engine airplane. One of the factors which militate against this opera-

(*Please turn to page* 88)

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Method of Curing Concrete Supersedes Usual Straw Covering

SODIUM silicate is one of the most versatile chemicals. An adhesive for a thousand different applications, a detergent in dozens of washing operations, a water softener, and in hundreds of other rôles, this ubiquitous mixture of sand and soda plays its part, from preserving eggs to improving paint. Now comes a new application which promises to be visible to every motorist, for sodium silicate seems to offer many advantages as a medium for "curing" concrete highways.

Everyone is familiar with the traditional method of curing a new concrete road by covering it with straw which is periodically moistened. This treatment is designed to prevent too rapid drying of the fresh concrete, in order that the new road may attain its full strength and permanence. Wet straw does the trick nicely, if kept wet, but very often this is not done carefully. The findings of the Maryland Road Commission, working in co-operation with the United States Bureau of Public Roads, reveal an effective curing agent that is not so dependent for its success on the human element.

Silicate of soda, in these experiments, produced concrete as strong as that cured with wet earth; in fact, silicate-cured concrete at the end of six months had a crushing strength of 5364 pounds in comparison with 4855 pounds for concrete cured with wet earth. Also a study of the number and distribution of cracks showed that on this job the section cured with silicate of soda had the least number of cracks.

It has been found that the silicate for concrete curing should have a ratio of 1:3.25 or 1 part sodium oxide (Na_2O) to 3.25 parts of silicon oxide (SiO_2). This is now available to contractors at a density of 42.25 to 42.75 degrees, Baumé.

Since the gravity of the silicate as applied is 36-37 degrees, Baumé, it is diluted on the job. This is easily done by adding about one gallon of water to four gallons of silicate. Checking with a hydrometer is important to be sure of the specific gravity.

To spread the silicate on the road, it is poured from pails or sprinkling cans, although some contractors use sprayers. A soft brush, mop, or push broom is all that is required for a spreader. When the silicate is spread the contractor's work is done. One application is all that is needed. A second application becomes necessary only if it has rained within six hours after the original treatment. There is no further attention required. Wet earth or straw curing involves extensive water lines, labor for an additional 10 days at least, and then the cost of removal. With silicate curing there is nothing to be removed. The appearance of the road is the same as it is with any other curing.

Humidity Effects Motor Performance

POPULAR beliefs, scorned for a time as superstitions, are often later found to have at least a partial basis in fact. The idea that smoother performance is obtained in wet weather is firmly intrenched in the minds of most automobile drivers.

This impression is doubtless partly the result of psychological factors, and partly a real absence of squeaks caused by the lubrication of the springs by water. However, recent tests at the United States Bureau of Standards indicate that it may result partly from mechanical factors. These tests show that increased atmospheric humidity, or "wetness" reduces the maximum power obtainable and slows up the combustion, the effect of both of which would be to give a smoother flow of power.

The loss of power is proportional to the humidity, and under extreme atmospheric conditions may amount to 10 percent of the total power of the engine.

Although by proper adjustment of the carbureter, equally efficient operation can be obtained irrespective of the humidity, in the absence of such adjustment, less efficient performance normally will be obtained under conditions of high humidity.

Superior Lacquers From Vinyl Resins

LACQUERS that are waterproof and more highly resistant to wear and tear than anything heretofore known are foreshadowed by the development of new synthetic resins which can be used as a base for entirely new surface coatings. Mention is made in these columns (see page 76) of "Glyptal," a new synthetic resin made from glycerine and phthalic anhydride. Now comes another series of synthetic resins promising even wider scope of application, the vinyl resins.

The development of these remarkable compounds was described at a recent meeting of the American Institute of Chemical Engineers by J. G. Davidson. After tracing the remarkable growth in the production of nitrocellulose lacquers and the corresponding decrease in the costs of the aliphatic chemicals and solvents that enter into their formulation, Mr. Davidson demonstrated the properties of some of the most interesting of the newer synthetic resins.

For more than two years his company has been working on the polymerized vinyl compounds, which are of particular interest

Illustration courtesy Philadelphia Quartz Company

Steps in curing concrete. ***Above, left to right*****: removing silicate of soda from drum, diluting with water, and mixing the solution.** ***Below*****: Spraying silicate solution on fresh concrete and smoothing it over concrete road**

in lacquers because they dry in a similar manner to paint and varnishes; that is, by polymerization rather than solely by evaporation, as is the case with lacquer. This means that more film-forming constituents may be left on the surface than with lacquers. Thus while the total solids in a lacquer rarely exceed 25 percent, in varnishes and paints and likewise in vinyl resin lacquers, it is possible to reach 50 to 60 percent of total solids.

Lacquers made with the vinyl resins, according to Mr. Davidson, are waterproof, remarkably resistant to acid or alkali, and can be produced in any colors. The same resins which are to be known by the trade name of Vinylite are thermoplastics and can be molded with or without fillers in any colors, including ivory white. They appear also to have advantages in impregnating fabric, paper, and wood. Their development marks the beginning of a steady evolution through which the lacquer industry will grow to increased size and economic importance, largely as a result of parallel developments in the field of synthetic aliphatic chemistry.

Mineral Wool Made From Lead Slag

A CHICAGO concern has worked out a process for making mineral wool from slag. This mineral wool, which is being put upon the market under the trade name of Therm-O-Proof, is a fluffy and light substance that will not burn or melt at less than 2500 degrees, Fahrenheit, and is being used for insulating material. The only plant manufacturing this wool at present on a commercial scale is at Alton, Illinois, where it is being operated on slag obtained from the lead refinery plant of American Smelting and Refining Company.

Approximately 50 tons of this material is now being turned out daily in Alton, and very soon this output will be increased. It will be marketed in four forms; loose wool, in blanket form, in board and bricks. The principal uses of the material are in building insulation, high and low temperature insulation, sound deadening, and fireproofing.

"Eskimo Pie" Idea Applied to Wolf Poison

NOT all the ingenious discoveries of chemists originate in laboratories. In fact, one triumph of science we recently heard of was achieved by the versatile scientist's familiarity with Eskimo Pie. One of the clients of Arthur R. Maas, consulting chemists of Los Angeles, asked the chemists to prepare a tasteless strychnine for poisoning wolves, foxes, and other predatory animals that kill sheep and cattle. Strychnine is very bitter, and if the "varmints" taste it, they cough up the baits. Also, a quick-acting form was wanted so the furs could be recovered before being damaged.

"We tried mixing with disguising materials, like sugar," said Mr. Maas, "but with no success, as the bitter taste remained. Then, with things that dissolved slowly in saliva—that was too slow. Then we remembered that a chocolate-covered ice cream bar seems to lack taste, and as a layer of wax separates the ice cream from the chocolate, we tried incorporating strychnine with wax. Complete success! The wax protects the poison from saliva, and it is swallowed without being tasted. In the stomach the wax soon dissolves by warmth, and there is a quick kill."

The formula has been highly effective in killing wolves and foxes, and the ranchers now welcome prowling animals because they drop before they do any damage and their skins pay a nice profit.

Bacteria May Supply Chemicals

FERMENTATION methods still play the most important part in solvents production, according to a paper prepared by F. M. Crawford for the Institute of Chemical Engineers. Starting in 1920 with an output from only a few fermenters, the demand from the lacquer industry for n-butyl alcohol has increased by leaps and bounds until in 1929 approximately 150 fermenters, each of 50,000-gallon capacity, are needed to keep up the required rate of production. The original plant capacity at Terre Haute, Indiana, was soon outgrown. A second and a third plant were built at Peoria, Illinois.

During the fermentation, tremendous quantities of gases are given off, consisting of a mixture of approximately 40 percent of hydrogen and 60 percent of carbon dioxide. More than half of the carbohydrate entering into the fermentation process goes into the formation of these materials, which at the Peoria plant are are being converted into synthetic methanol.

Mr. Crawford predicts that bacteria will play an increasing part in the production of commercial chemicals and foresees a time when our exhausted petroleum reserve will be replaced by fermentation processes for the manufacture of the many solvents and chemicals which are now derived from petroleum.

Diphenyl as a Heating Medium

ONE of the most spectacular developments of an erstwhile rare chemical to an everyday commodity for entirely new uses is exemplified by the application of diphenyl as a heating medium. This organic solid changes to a gas at 484 degrees, Fahrenheit, and is therefore ideal for a heating medium between that temperature and 750 degrees, Fahrenheit, just as water, for instance, is an ideal medium for the temperature range covered by steam. The most important application of the new heating medium seems to be in the Govers process for refining lubricating oils.

A. E. Wells, a consulting engineer of Cambridge, Massachusetts, read a preliminary paper on the use this process makes of diphenyl as a heating medium in distillation at a recent meeting of the Institute of Chemical Engineers. Dr. Francis X. Govers, director of research for the Indian Refining Company, answered questions and demonstrated the operation of the process. The problem of producing a special grade of lubricating oil distilling between 485 and 625 degrees, Fahrenheit, called for the use of an indirect heating medium. After considering various low-melting metals, mercury, and sulfur vapors, it was decided to use diphenyl, which has a vapor pressure of 110 pounds at a temperature of 750 degrees, Fahrenheit.

There is apparently no decomposition at this temperature, for Dr. Govers reported that when used continuously in their apparatus for over six months, the make-up amounted to less than ½ percent. Diphenyl produced for this process on a commercial scale for the first time by the Federal Phosphorus Company, of Birmingham, has a melting point of 158 degrees, Fahrenheit, a boiling point of 474 degrees, Fahrenheit, and a specific heat of 0.4. Its thermodynamic properties are being studied at the University of Michigan and elsewhere.

In the Govers process the diphenyl is vaporized in a tubular heater similar to a modern boiler and the vapors pass to a single-effect vacuum evaporator where a mineral oil fraction between 485 and 625 degrees, Fahrenheit, is volatilized and taken off in an overhead condenser. Pressure in the still is about five millimeters. It is reported that with a waste heat boiler the entire process has shown a thermal efficiency of 83 percent.

Spectrum of Chlorine Gas

VALUABLE additions to our knowledge of the spectrum of chlorine, an element whose spectral characteristics have been practically unknown heretofore, and data tending to show that so far as we are now aware, chlorine does not exist in the sun, were made available to physicists and astronomers through a report published in the June 1929 number of the Bureau of Standards *Journal of Research*.

Several years ago Prof. H. Kayser, of the University of Bonn, in reviewing the research work done on the spectrum of chlorine, made the statement that, in spite of all the investigations that had been made up to that time, the spectrum was still practically unknown. The cause for this situation lies in the fact that chlorine is a difficult element to observe spectroscopically. When an electric charge is passed through the gas at reduced pressure in a glass tube, it rapidly enters into chemical combination with the hot metal electrodes and the discharge tube soon becomes useless. This defect has been eliminated in an experimental procedure at the Bureau, whereby a small portable chlorine generator is attached to the discharge tube, thus permitting small amounts of the gas to be admitted to the tube to replace that which has combined with the electrodes.

With such a tube it was possible to produce the spectrum of chlorine for the long periods of time (up to 15 hours) necessary to photograph it in the regions where it had never previously been observed. As a result of this new investigation our knowledge of the spectrum has been extended from the wavelengths visible to the eye in the violet and blue to those in the infra-red, beyond the limit of visibility, but capable of being photographed with specially sensitized plates.

Our modern theories of the structure of the atom enable us to predict the type of spectrum which the atom will radiate when it is losing the energy imparted to it, say, in an electric discharge. These new spectrum lines have been classified into spectral series and it is found that these conform in every detail to the theoretical requirements.

Steel-Coated Paper Money

NO sooner does the government reduce the size of paper currency than the chemist comes along with a plan to make money last longer. By means of a process developed in the laboratory of Dr. Schoop, of Zurich, and reported by *Chemistry and Industry*, banknotes are coated with a particular steel alloy in such a way that metal and paper are firmly combined without damage or alteration to the paper. In addition to such advantages as durability, it is claimed that the metallized notes can not be forged.

Synthetic Lacquer Has Synthetic Name

It is only five or six years since "Duco" and other pyroxylin lacquers made their appearance in the paint and varnish field and began the conquest that left them supreme in certain important applications. The development of the quick-drying pyroxylin lacquer has been the sensation of the protective coating industry during the past decade. Yet the tempo of science and industry is so fast that already a new pretender for the throne of pyroxylin is marshalling his forces in American chemical laboratories, and some scientists are anticipating a new conquest by synthetic resin lacquers.

Chief among the picturesque resin aspirants to supremacy is Glyptal—a synthetic resin with a synthetic name, formed from the words "glycerin" and "phthalic anhydride," the two substances from which it is made. Developed in the great research laboratories of the General Electric Company, Glyptal is the result of a successful search for an improved synthetic non-conductor of electricity. In its solid form it is a resin somewhat similar to the well-known Bakelite; when dissolved, it produces quick-drying lacquers with surprising qualities which are winning new converts and customers every day.

The first commercial applications are for sealing joints in gas mains, for painting structural iron, motors, oil tanks, metal parts of ships exposed to oil or vapors, fire hydrants, ship hulls, mine machinery, and similar equipment requiring sealing and insulating paint. The General Electric Company is marketing a series of Glyptal lacquers in colors, for use where an oil-resistant, highly protective, durable, and flexible insulating coating is demanded.

These paints possess many desirable qualities, including resistance to acids, mineral oils, weather, and alkalies, as well as adhesion to any surface and protection against rust. The Glyptal lacquers have been found superior to ordinary protective paints, in that they are more easily applied, dry faster to a coating of more pleasing appearance, are more resistant to acids and mineral oils, and are less affected by high temperatures. They withstand temperatures destructive to the commonly used paints, and also have a greater dielectric strength.

These new lacquers are now available in five colors—red, blue, brown, green, and aluminum. They may be applied by brushing, spraying, or dipping, dry dust-free in about 30 minutes, and in approximately ten hours to a hard smooth finish which is not brittle and can be cleaned easily. When using Glyptal lacquers as a finish, no priming or sizing is necessary.

Mold Used to Make Gluconic Acid

The despised mold, popularly considered only destructive, is now used in the making of a health-giving product by the United States Department of Agriculture. The process of putting molds to work in producing gluconic acid, used in making an expensive calcium salt with highly important medical qualities, was discovered and recently perfected by Horace T. Herrick and Orville E. May, chemists in the Bureau of Chemistry and Soils of the department. By the new method, this salt is reduced in cost from about 15 dollars a pound to 50 cents a pound. "This," says Dr. Henry G. Knight, Chief of the Bureau, "is an example of the manner in which the bureau is using apparently useless organisms to create valuable chemicals.

"The calcium gluconate which is made from the gluconic acid produced in the Color and Farm Wastes Division of the bureau is now regarded as the only calcium salt which can be injected between the muscles, in the treatment of certain ailments of man, without causing abscesses. In common with other calcium salts it can be injected into the blood stream or given through the mouth and, in contrast to the exceedingly disagreeable taste of other calcium salts, it is practically tasteless.

"Until Mr. Herrick and Mr. May discovered the kind of mold that produces gluconic acid, learned to feed this mold the right amount of glucose, learned to keep it in a liquid of the right temperature, perfected large containers which would not corrode from the action of the acid and finished other laborious research, calcium gluconate remained a rare medicine, manufactured by chemical processes and held at exceedingly high prices by certain European manufacturers."

It is believed that calcium gluconate, when fed to high-production hens which lay thin-shelled eggs, may have a marked and unusual effect in thickening the shells. It is considered possible that the textile and tanning industries will also make use of gluconic acid.

Extend Investigation of Rare Gases

In our June, 1929, issue we described the process of manufacture of the glowing colored tube electric advertising signs, explaining the effects produced by the use of neon, argon, helium, and mercury vapor in the tubes. We are reproducing this month a photograph showing an important step in the manufacture of these popular advertising signs in which the air is completely exhausted from the tubes before the introduction of the rare gases.

The popularity of these advertising signs has opened up a tremendous field for neon gas, which was previously nothing more than a chemical curiosity. Now we are informed that new possibilities for the commercial development of still other rare gases are in prospect as a result of the research work of a French chemist, M. Lepape. He has succeeded in obtaining appreciable quantities of krypton and xenon, both of which are present in the air in minute quantities, by fractionating the residual gases from liquid air. In apparatus of the type used by Claude for the liquefaction of air, the krypton and xenon are entrained in the ebullition of liquid oxygen. In order to reduce loss of these gases through mechanical entrainment, M. Lapape employs fractionation by means of adsorption at the temperature of liquid oxygen. By using coconut charcoal or silica salt with the liquid oxgen in the process of evaporation, the mixture becomes enriched in krypton and xenon, which are subsequently separated by fractionation on the coconut charcoal. By this method M. Lepape has been able to recover from air several liters of krypton and one liter of xenon.

Wanted: Uses For Columbium

At the recent Chemical Exposition, in New York, columbium was exhibited for the first time. Because of the remarkable properties of this new metal, speculation was rife among chemists as to where application of the newcomer would first be made. The metal exhibited is said to represent all of the metallic columbium in the world. The metal has an atomic weight of 93.5, its specific gravity is 8.3 and its melting point is about 1950 degrees, centigrade.

Columbium is silvery in appearance and may be coated with iridescent, colored oxides by electrolysis. Like tantalum, it is inert to practically all chemical action and is soluble only in a mixture of nitric and hydrofluoric acids. The metal readily absorbs gases by occlusion, is very ductile, and may easily be worked cold. It may

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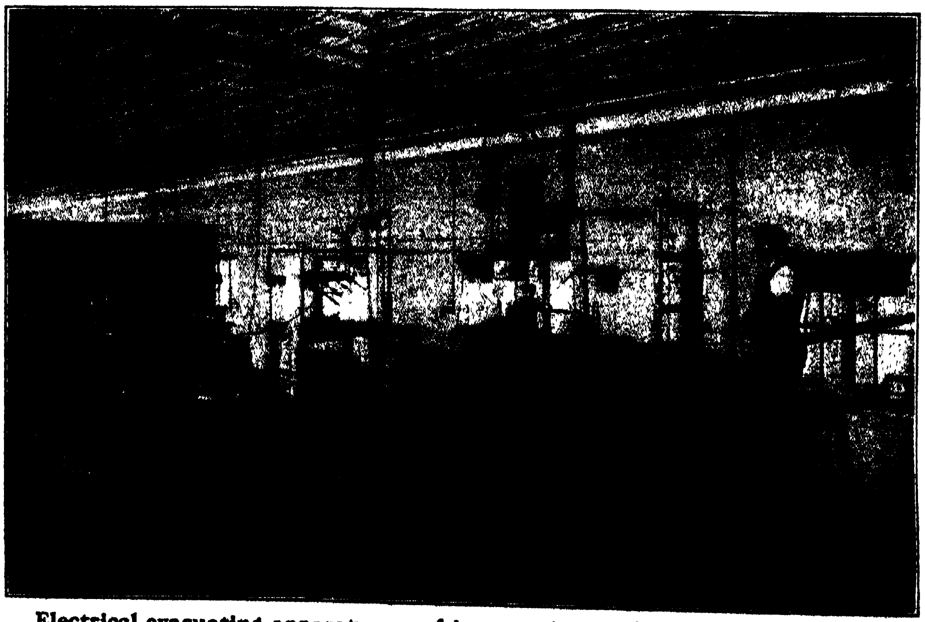


Electrical evacuating apparatus, used in removing air from glass tubes prior to the introduction of luminous gases. A current of 16,000 volts is required

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.

Editor of the Journal of the American Medical Association *and of* Hygeia

The Composition of Cigaret and Cigaret Smoke

DR. EMIL BOGEN has made available the results of his investigation of cigarets sold in the American market. More than 286 brands are purchased by American smokers, varying from pure oriental cigarets made of Turkish and Egyptian tobacco to the pure domestic brands made of Virginia and Carolina tobacco. In addition, there are innumerable blended tobaccos of which the most popular cigarets are typical, as well as denicotinized tobacco cigarets and tobacco-free cigarets. In his investigation, Doctor Bogen found that it was not possible to differentiate regularly between cigarets of the same class, but that experienced smokers when blindfold can tell the difference between cigarets of different classes.

The moisture content and nicotine content of tobacco varies. Domestic brands average 2.50 percent of nicotine, blended tobaccos 1.90, oriental tobaccos 1.44, and denicotinized tobaccos 1.10. There is thus but a small limit of differentiation in nicotine content between denicotinized and oriental tobaccos.

Doctor Bogen recognizes that the chemical composition of the cigaret is not the only factor that may affect the response of the smoker. There is the inhalation of the smoke, the heat, and the deposition of the ingredients in the tissues. In an interesting table, Doctor Bogen contrasts the pains and pleasures of cigaret smoking as represented by the average number of men undergoing blindfold tests.

Pains and Pleasures of Cigaret Smoking

Percentages reported by subjects of blindfold tests.

I. The Pleasures of Smoking	Percent
Sociability	65
Fragrance	60
Relaxation	50
Stimulation	50
Steady nerves	45
Smoothness, mellowness, and soothing	35
Quieting hunger	30
Sight of the smoke	25
Feel in the lips	25
Feel in the hand	10
Taste	5

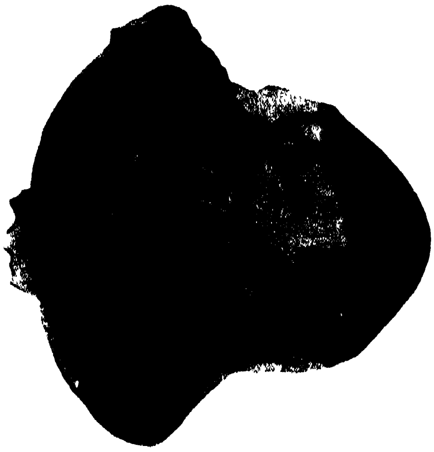
II. The Ill Effects of Smoking	Percent
Shortness of breath	35
Biting and irritation	30
Coughing	30
Burning	15
Nausea	10
Palpitation of heart	5
Hoarseness	5
Salivation	5

A definite relationship was also found between underweight and persistent use of tobacco. Those who use no tobacco were usually overweight and showed a lower incidence of colds and respiratory diseases.

The Lens of the Eye

ALMOST everyone knows that the eyes of animals, insects, and fishes are adapted to the nature of their lives. This applies not only to the retina of the eye, the portion which accurately conveys the vision to the brain, but also to the lens of the eye which acts as a mechanism for focusing the image on the retina.

Dr. John O. McReynolds has made extensive studies of the lens of the eyes of various species, which indicate some of the remarkable conditions that exist. There are some beetles which have thousands of eyes and thousands of lenses. Consider the marvels of the mechanism of the eye of a bird which enables it while flying swiftly to alight with accuracy on a swinging telephone wire or to catch in its beak an insect flying in a diverging course. The eyes of many species are both telescopic and microscopic. The eyes of fish are adapted to the medium in which they live. The owl's eye is interesting, according to Doctor McReynolds, because of the prominent part that the cornea, which is the tissue over the eye, plays in helping the owl to see satisfactorily.



Owl's eye, *Bubo virginianus*. This represents a meridional section of the eye. The enormously protruding cornea is a combination of cylinder and cone and performs an exceedingly important function in the refraction of light

The Malingerer

THE malingerer is usually mentally disturbed. In order to excite sympathy in one in whom he or she, and it is usually she, is interested, he will inflict all sorts of strange injuries on his person. Sometimes in order to avoid hard work or military service, he will claim deafness, inability to see, or even disturbance of the kidneys. During the war there were many such cases. Instances actually occurred in which egg white or similar substances were injected into the bladder so that excretions might reveal the presence of albumin on examination.

Among the strangest of all malingerers are those who inflict injuries on the skin. Every specialist in diseases of the skin has seen numerous cases of this character. Recently, Doctors Stokes and Garner of Philadelphia have described a remarkable case of this kind. A married woman, 40 years of age, developed typical hysterical symptoms, including attacks of rigidity, sleeping spells, and disturbances of vision, and at the same time white spots and scars on the skin. A specialist is able usually to detect the fact that the skin disturbance is self-inflicted.

Usually it is not an eruption on the skin, but an ulcer or an erosion due to the action of some burning or caustic substance. In 34 cases seen by one specialist, 14 were due to the application of carbolic acid or phenol, which had been used to produce burns and scars. Usually the interest of the specialist is aroused at once by the fact that the skin disturbance does not resemble any ordinary skin disease. However, it is possible to injure the skin merely by rubbing it with a wet finger or by applying sand-paper, acids, mustard, tobacco, or more caustic substances.

It is usual for the self-inflicted wound to be in a place that the hand can easily reach. In a left-handed person the scars are on the right side, and in a right-handed person on the left side.

Among symptoms of nervousness which are likely to appear in such people are bitten finger nails, bitten knuckles, and hangnails. Indeed, Doctors Stokes and Garner speak of the nervous restlessness, the slight tremors of the finger muscles, the easily moist or overbright eye, or the "poker" face of the outwardly calm, although inwardly tense, person as typical malingerers. In practically every case it is possible to find a background of motive which may be sexual or associated with a love affair. Jealousy, self-pity, and morbid craving for sympathy are the chief causes of malingering.

In the case of the girl in Escanaba some years ago who deceived physicians for many weeks with an extremely high fever brought about by touching the thermometer to the hot water bottle, it was the desire to attract the attention of some one who was not interested. However, in addition to the jealousy motive, there may be moral, religious, intellectual, or economic reasons for producing the disturbance.

An Exclusive Meat Diet

EXPERIMENTS just completed under the direction of Dr. C. W. Lieb served to confirm the observations made by the Arctic explorer Stefansson when he returned *from the far north after having lived for many years on what was practically an exclusive meat diet. At that time observations showed that no definite physical or other changes had occurred in Stefansson.*

The people who opposed the eating of meat on prejudicial ground attempted to explain the facts by asserting that he had been able to withstand high protein and fat diet due to the cold air or to his vigorous exercise. As a matter of fact, summer heat comparable to that of our own country was experienced part of the time, and, indeed, winter temperatures in the far north are for the human being much like those of our own climate, because of the furs that are worn and the temperatures that are maintained in Eskimo houses.

For the purpose of the experiment, Stefansson and Andersen, who spent three years with him in the Arctic, consented togo on an exclusive meat diet for a year and to be studied from all angles during the period of the experiment. For a year, therefore, they lived on meat, most of which was cold-storage meat, although for a period of two months they had fresh meat. Calcium was obtained by eating the ends of the ribs and gristle. Very little salt was added to the food. Raw bone marrow was eaten as dessert at times during the year of the experiment. Coffee and black tea and water were the sole beverages and were taken unsweetened.

It is pointed out that both the men were excellent subjects from the psychologic point of view, since they had previously lived on limited diets and had no mental hazards as to the outcome. There was little if any change in their weights and no disturbances of the kidneys. The diets averaged 2600 calories per day. The blood pressure of Stefansson did not change and Andersen's blood pressure fell from 140 millimeters to 120 millimeters. There was no decrease in physical vigor and both men appeared ruddier at the end of the experiment than at the beginning. The teeth did not deteriorate, the bowels remained normal and there was no change in pulse, temperature, or ability to sleep.

It has been argued by some of the opponents of meat in the diet that the eating of meat brings into the bowels vast numbers of dangerous bacteria and therefore is bad for the human body. The investigation revealed the fact that the whole meat diet in both subjects caused a simplification of the germs in the intestinal tract and did not cause the development of putrefactive germs.

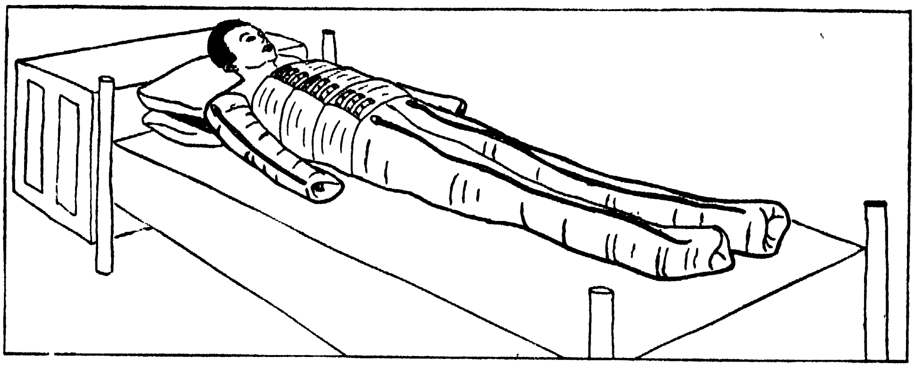
The results of this experiment should not be considered, however, as a recommendation for eating vast quantities of meat or of meat alone by the majority of people. The experiment does break down, however, the arguments of the vegetarians as to the dangers of meat. The fact remains that the best diet for the human being is a well balanced mixture of all of the foods commonly eaten by man, including meat, eggs, fresh vegetables, cooked vegetables, fruits, and cereal products.

An Apparatus for Muscular Relaxation

It has been generally agreed that relaxation of the muscles, whether produced by mental action or by physical process, is conducive to sleep. Dr. Edmund Jacobson has devised a system called "progressive relaxation," in which the patient is taught in a series of lessons to relax muscle after muscle until he finally learns to relax his *entire body. It has long been known that gentle massage and a hot bath will produce the same relaxing effect.*

It occurred to Dr. Joshua Rosett to develop an apparatus which by alternately compressing and releasing the tissues would produce a similar effect. The device is like a union suit, made of strong inelastic rubberized cloth and is composed of a series of collapsible tubes which encircle the limbs and the body as high as the line of the armpits. By means of an air compressor and exhaust, compressed air enters the garment in such a manner that the tubes are momentarily inflated and deflated one after another in succession, in a direction from the extremities toward the upper part of the chest and shoulders. The degree of pressure is regulated by valves and the speed of the wave is regulated by another apparatus.

This garment has been in use, according to Doctor Rosett, for more than three years and people who try it say that it produces a gentle massage all over the body as if by many fine fingers. The uniform effect has been that of relaxation. Patients with nervous and mental diseases who are excited and do not sleep apparently fall asleep in this device. Experiments are being conducted to determine its usefulness.



An apparatus for the induction of muscular relaxation and sleep

Deaths from Pugilism

Some time ago Dr. H S. Martland pointed out that several puglists had died and others developed mental disturbances due to the development of a condition called "punch drunk." This condition is the result of small hemorrhages in the brain caused by repeated concussions. Recently pugilism has become more and more popular in Germany. Although boxing was common in ancient Greece and Rome, it did not become popular in Germany until after the World War.

Now the Germans are beginning to observe cases similar to those described by Martland. Kurt Wolff, the German pathologist, lists 25 deaths, in seven of which the fatality resulted from hemorrhage into the brain due to a blow on the side of the head.

The casualties in boxing are usually due to matching inexperienced boxers with better trained and heavier opponents, or to holding matches soon after a full meal or while the boxer is suffering from some disease.

Speech and Intelligence

The mother is invariably interested in the question as to when the child will begin to talk. In the Institute for Juvenile Research in Chicago investigation was made *of this particular point. The acquirement of speech is one of the most important functions in human development. Unquestionably speech is learned more rapidly in infancy than in adult life as everyone* knows by comparing the ease with which language is acquired in infancy with the difficulty of acquiring a second language later in life. A thousand children were studied as to the age of onset of talking and walking, and this was compared with the mental age, intelligence quotient, nationality, and similar factors.

Doctors Abt, Adler, and Bartelme, who made the study, find that the range in onset of talking extends from 6 to 60 months for both boys and girls. The average age for talking for boys is 19 months and for girls 18 months. Practically all observers agree that girls learn to talk quicker than boys.

In comparing the age of onset of speech with intelligence rating, it is pointed out that the higher the intelligence the earlier the child learns to talk. The average age of speech onset was lowest in the Jewish group and highest in the group with both parents foreign born.

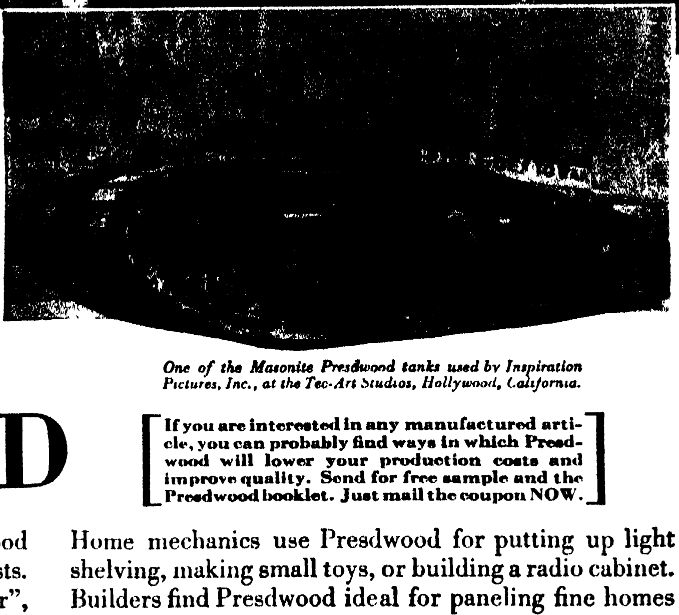
The average of onset of walking for both sexes is 16 months, ranging from 7 to 51 months for boys and 7 to 60 months for girls. There is also a definite relationship between the age at onset of walking and general intelligence.

It was noted in addition to this, that children who wet the bed at the age of three years or above learn to talk later than those who have established dry habits prior to that time.

The Hearts of Athletes

During the Olympic Games held in Amsterdam last year special studies were made of the hearts of the athletes by Doctor Herxheimer of Berlin who has for many years been interested in this subject. During the Amsterdam games, the hearts of 246 athletes engaged in various branches of sport were studied with the X ray before and after activity and their sizes were compared with the body weight.

Short-distance runners and athletes participating in a variety of sports had hearts which differed but little from those of the average men. The same is true of long-distance swimmers. On the other hand, marathon runners tax the heart severely, their hearts being the largest of athletes in any branch of sport. Next to the marathon runners were heavy-weight lifters and throwers, the oarsmen, and the long-distance bicycle racers. **Boxers also place a heavy tax on the heart, as was shown by the high rates of weight and size of the organ in this type of athlete.**



One of the Masonite Presdwood tanks used by Inspiration Pictures, Inc., at the Tec-Art Studios, Hollywood, California.

This tank looks like steel—*but is made of* PRESDWOOD

If you are interested in any manufactured article, you can probably find ways in which Presdwood will lower your production costs and improve quality. Send for free sample and the Presdwood booklet. Just mail the coupon NOW.

In both movie studios and factories, Masonite Presdwood is helping to win the war against rising production costs. In monster tanks of the feature film, "She Goes to War", this grainless wood forms most of the superstructure. Here Presdwood is used for its lightness, workability, smoothness, strength, and ability to take any finish.

Makes all these things

In great factories, carload after carload of Presdwood goes to the punch press, band saw, or milling machine to be transformed into useful articles. Presdwood makes iceboxes and incubators. It builds beehives and bird houses; is used in the manufacture of clothes hampers, bread boxes, breakfast nooks, kitchen cabinets, campers' tables, radio cabinets, speed boats, table tops, outdoor signs, and scores and scores of other interesting products.

Home mechanics use Presdwood for putting up light shelving, making small toys, or building a radio cabinet. Builders find Presdwood ideal for paneling fine homes and modern buildings. Contractors, employing Presdwood for lining concrete forms, find hand smoothing unnecessary except at construction joints, and thus effect savings of as much as 40 per cent in labor costs.

Manufacturers and builders have a wonderful material in this grainless wood, for it neither cracks nor splits, is highly resistant to moisture, and does not warp when properly handled. The Presdwood booklet explains its uses—tells how various finishes are applied. A copy is waiting for you and will be mailed on receipt of the coupon.

MASONITE CORPORATION
111 West Washington Street, Chicago, Illinois

MASONITE CORPORATION, Dept. E-1, 111 W. Washington St., Chicago, Ill.
Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.

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Engineering

Selected Papers from the Journal of the Institute of Electrical Engineers of Japan are issued in English either in full or in abstract, for the purpose of introducing to the Western public the gist of the papers published in the Journal of the Institute of Electrical Engineers of Japan. *Denki-Gakkwai, No. 3, 1-Chome, Yurakucho, Kojimachi-ku, Tokyo, Japan.—Prices Upon Request.*

Abridged Scientific Publications from the Kodak Research Laboratories (Volume XII) is a compendium of many important scientific papers published during 1928. *Eastman Kodak Company, Rochester, New York.—Gratis.*

Plans For Systems of Sewerage, Sewage and Waste Disposal is a 28-page pamphlet of particular interest to engineers engaged in the design of municipal, institutional, industrial, and private sewage systems. *Division of Sanitation, 23 South Pearl Street, Albany, New York.—Gratis.*

Index of Technical Reprints gives the titles and writers of numerous reprints issued by the Bell laboratories to date. *Bell Telephone Laboratories, Incorporated, 463 West Street, New York.—Gratis.*

Industry

The Oxford Process for the Production of Sugar from Sugar Beets is a report devoted to the development and costs of the Oxford dessication process, with statistics for comparing with the diffusion process. *Oxford University Press, 114 Fifth Avenue, New York.—85 cents.*

The Conservation of Industrial Acreage is a bulletin of the Pennsylvania Railroad showing the need for exercising wisdom and foresight in developing industrial property, and enumerates certain pitfalls to be avoided by owners of industrial property, leaders of business and civic associations, and municipal and state officials. Another recent publication of the company is entitled, What Two Pennsylvania Railroad Men Saw in South America. Their story is very interesting. *Information Service, Pennsylvania Railroad, Philadelphia, Pa.—Gratis.*

Lubrication in the Presence of Water, a special issue of one of the Texas Company's periodicals, discusses from various angles the problems concerning this type of lubrication and the most practical solutions thereof. *The Texas Company, 17 Battery Place, New York.—Gratis.*

Everything for Mine and Industrial Safety, including the Edison safety lamps, is a well-indexed 158-page catalog. *Mine Safety Appliances Company, Homewood Station, Pittsburgh.—Gratis.*

Carbon-Black in 1928, by G. R. Hopkins and H. Backus of the Bureau of Mines, presents complete statistical data and summaries of the carbon-black industry in 1928, when it set new high records for both production and sales, due in part to the steadily increasing demand for rubber automobile tires. The figures show a consumption of nearly two pounds of carbon-black per tire. Most of the carbon-black is produced in Louisiana, Texas, and Wyoming. *United States Government Printing Office, Washington, D. C.—Five cents.*

Natural Gas Pipe Lines in the United States is a map showing the location of natural gas pipelines, and the natural gasoline and carbon-black plants of the country. *Bureau of Mines, Department of Commerce, Washington, D. C.—50 cents.*

Medicine

San Francisco Cancer Survey, by Frederick L. Hoffman, is largely limited to Canada. The compilation is the fifth treatise of a series which began as a statistical survey of cancer on the Pacific Coast. *Prudential Insurance Company, Newark, New Jersey.—Gratis.*

Annual Report of the Medical Department of the United Fruit Company is a well-indexed 378-page book covering the work done during 1928 in controlling malaria on the plantations of the company, and describes improved designs incorporated in new hospitals erected during the year. The book contains many valuable contributions by research specialists of the staff and others, dealing with various tropical diseases and other subjects of medical interest. *Medical Department, United Fruit Company, 17 Battery Place, New York City.—Gratis.*

Biology

Paleontology and the Evolution of Man, by D. M. S. Watson is the view of a conservative paleontologist concerning man's evolution. *Oxford University Press, 114 Fifth Avenue, New York.—70 cents.*

Neanderthal (Mousterian) Man, by Oliver C. Farrington and Henry Field, narrates in easily readable style the present knowledge concerning a race which maintained its existence in Europe for a period estimated at almost 100,000 years, and then became extinct after contributing knowledge of the uses of fire, improved stone implements, the beginnings of family and communal life, and some rudiments of a religious belief. *Field Museum of Natural History, Chicago.—25 cents.*

Miscellaneous

Suggestions to Authors contains pertinent information concerning manuscript preparation and book manufacture, particularly for writers in the technical field. *McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City.—Gratis.*

Revised Encyclopedia of Caged Birds contains advice, suggestions, and information for pleasurable or profitable care of caged birds. Questions are answered concerning bird selection and breeding, treatment and feeding, diseases, types of cages, and methods for training certain types of birds. *Audubon Publishing Company, Louisville, Kentucky.—Paper 75 cents, cloth $1.50.*

World Power Conference, Second Plenary Meeting, Berlin 1930 is the title of a pamphlet which outlines the nature and purpose of the next World Power Conference. *Zweite Weltkraftkonferenz, Berlin NW7, Ingenieurhaus, Germany.—Gratis.*

Beyond the Electron, by J. J. Thomson, presents the author's view as to the complex nature of the electron and its accompanying waves. *The Macmillan Company, 60 Fifth Avenue, New York.—80 cents.*

Photography at Ease is a valuable little handbook designed to help the photographer, whether amateur or professional, to make better pictures. *Burroughs Wellcome and Company, Incorporated. 11 East 41 Street, New York.—Gratis.*

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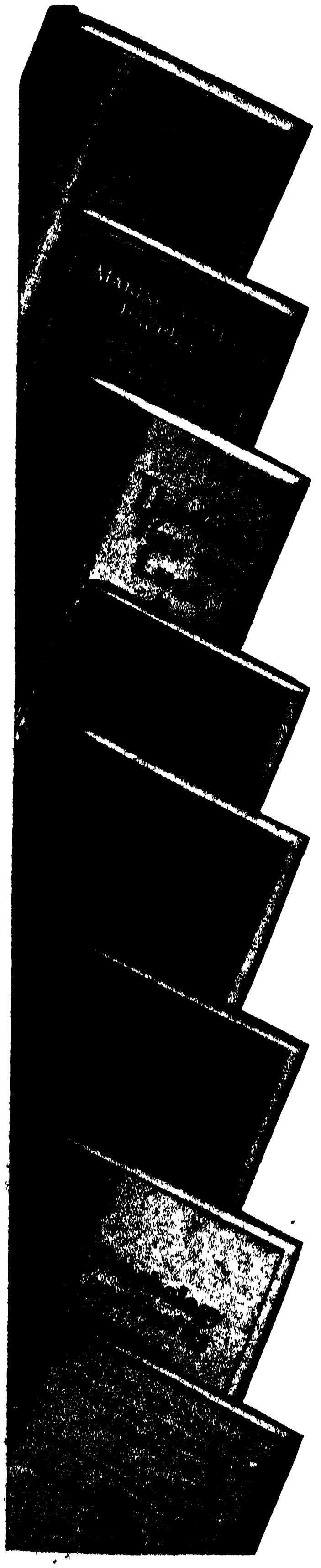

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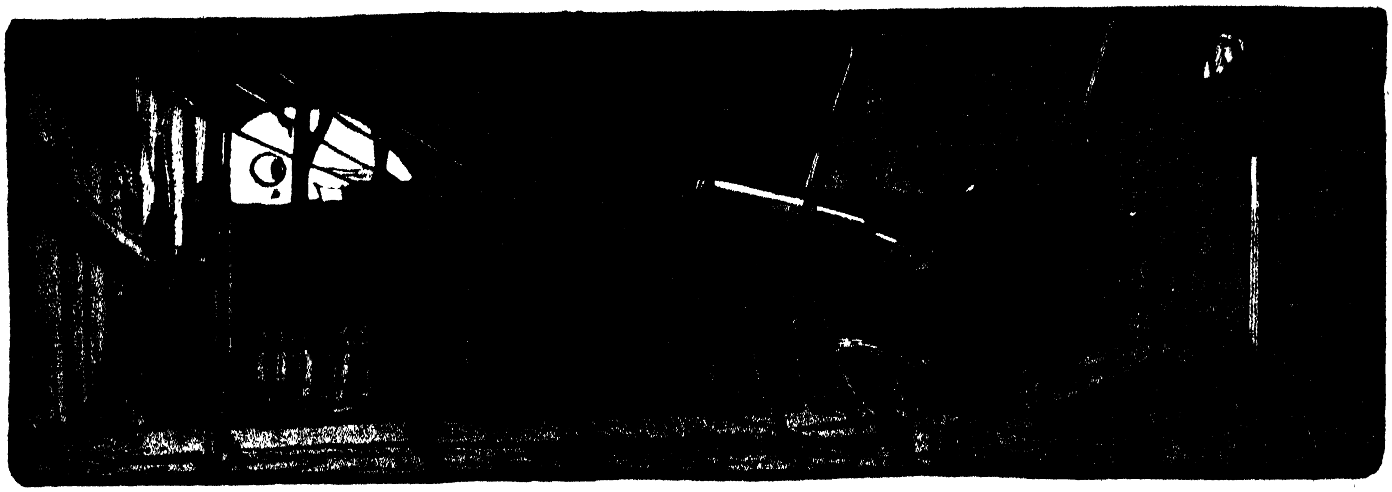


The Amateur Astronomer

THE hobby of the amateur telescope maker received its rebirth at Springfield, Vermont, several years ago, at the hands of a local society of amateurs, "The Telescope Makers of Springfield." We reproduce this month a winter photograph of "Stellafane," the mountaintop clubhouse of that famous society, taken by Oscar S. Marshall, its secretary. Before the mountain which "Stellafane" surmounts was officially renamed Mount Porter the neighboring farmers sometimes called it Breezy Mountain. It is so breezy in winter that the builders of "Stellafane" anchored each of the house's four corners to the Granite State by means of a steel cable let into the rock, so that the building would stay in the state during the Vermont winters. Amateurs who have visited "Stellafane" may behold it now shrouded in white, with the dead grasstops waving above the snowbanks, in the photograph.

ALL three of the other photographs this month are of lads who have taken up telescope making, the hobby which appeals to young and old. The first is Winston Juengst, Box 43, Croton Falls, N. Y , aged 16, who says he has scratches and a turned-up edge on his mirror, but such a good paraboloid nevertheless that the telescope "supplies a real thrill." Juengst is studying astronomy with seriousness. He plans an eight-inch telescope next, but this appears to be contingent on parental permission, as it seems he has also gone in for interior decoration, having redecorated the kitchen, where he made the first mirror, in red of a shade suspiciously resembling that of optical rouge.

Richard W Aldrich, 626 East Washington Street, Hoopeston, Illinois, aged 17, sends a picture of a four-inch mirror which "took a long time to make but finally came out all right." The total cost was not over seven dollars, he says, the eyepiece being from a "Kopton" optical set. He gets a magnification of 104 diameters.

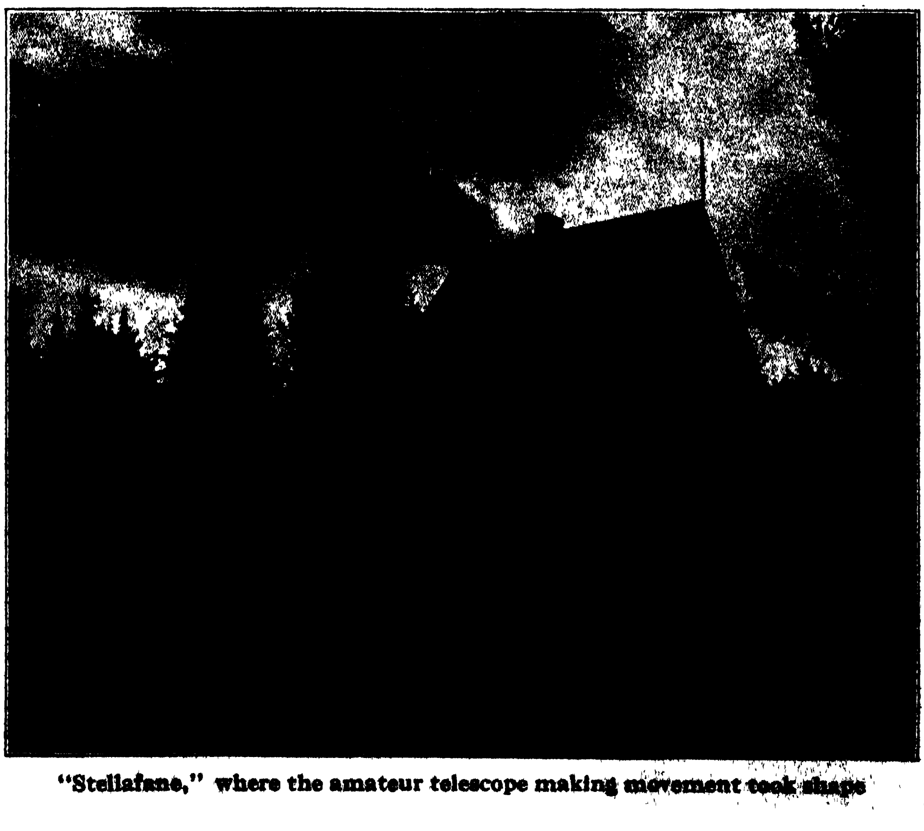
Reed Knox, Jr., of University Terrace, Deland, Florida, says he "sends us a picture of his telescope so far." It is his third attempt. He dropped No. 1 on a concrete floor and No. 2 refused to polish out, but each time he gains impetus. As he is still no more than 12 years old he has time to beat the 200-inch record about to be hung up. When he grows up he says he expects to be a professional astronomer. Probably Knox is our youngest amateur. Who claims to be our oldest?

LAST month we promised to publish an abstract of an article by Professor A. E. Douglass of the University of Arizona, entitled "Atmosphere, Telescope and Observer." This appeared in *Popular Astronomy* for June, 1897. Our abstract was sent to Professor Douglass with the idea that he might wish to alter it in the light of later experience, but he found nothing in it to alter. After all, however, the matters involved are basic and not a bit different in 1929 than in 1897, and therefore we make them available to our readers. Professor Douglass writes:

"Every astronomer knows that good seeing is not a matter of clouds and that the definition does not become superb merely because the atmosphere has become clear and perfectly transparent; on the contrary a certain amount of haze sometimes improves the seeing.

"Every possessor of a fair-sized telescope, has at hand a means whereby he may study the more obscure atmospheric conditions which accompany good and bad seeing and, at least in some cases, determine whether bad seeing is due to local conditions which may be evaded by moving a few miles, or to general conditions which may require a large change in latitude to correct. The means consists simply in placing the eye directly in the focus of the objective and watching the streams of air pass by overhead.

"The currents cast, as it were, their shadows on the objective and as all the light is concentrated in the focus, the eye can, without changing position, see all the irregularities in illumination which take

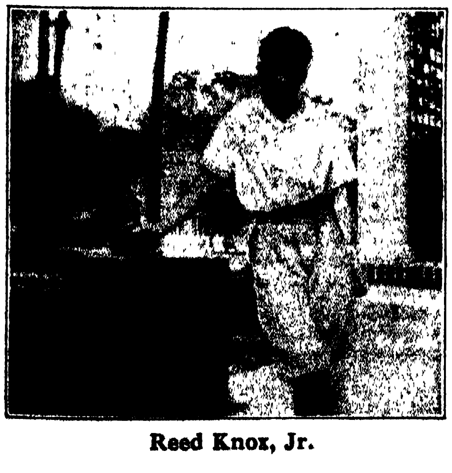


"Stellafane," where the amateur telescope making movement took shape

Winston Juengst

place over that area, that is, in the cylinder which extends from the lens to the limits of our atmosphere in the direction of the star. In the case of a planet of sensible diameter this volume is a truncated cone with its smaller end at the objective, instead of a cylinder. These differences of illumination are not real shadows but are condensations or rarefactions of light caused by the refractive power of the air. When, therefore, the objective brings all the light to a focus, the light from certain portions of the waves comes together inside the principal focus, and from other portions outside, so that an eyepiece may be placed behind these foci

Richard W. Aldrich



Reed Knox, Jr.

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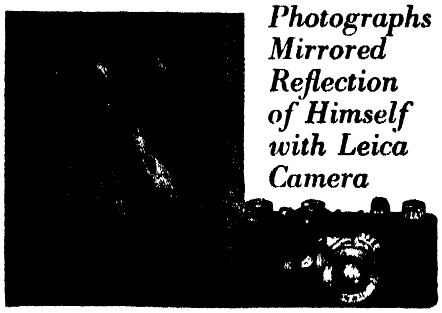

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at proper distances and the waves seen through it.

"The currents of course are usually observed at night but they may be seen in the daytime by using a small diaphragm at the focus to exclude the greater part of the light of the sky. By day they are extremely handsome.

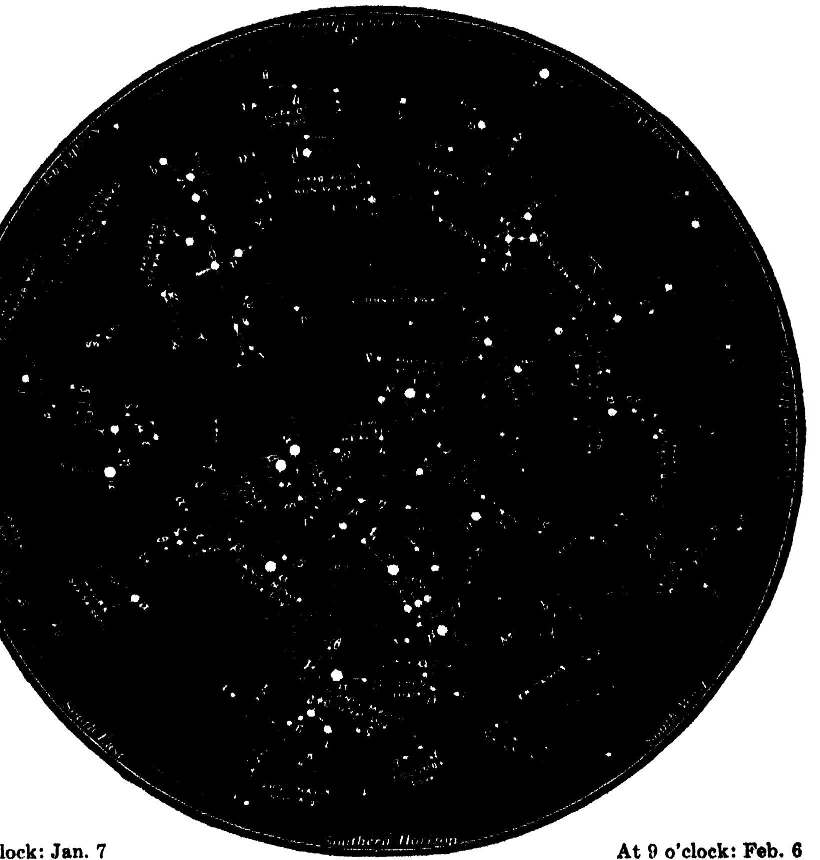
"In order to understand the subject better, let me cite a few familiar cases of the same or similar phenomena. The most ordinary instance is met with in sunlight upon shallow water. There, beneath each rising wave, the light is condensed, while beneath each trough the light is enfeebled. At a certain depth, depending on the character of the waves, the contrast between the crest and the trough is most marked. Upon going deeper the difference decreases, leaving finally only light and dark patches. I conceive the waves in the air to be very similar in their action, although having a different origin and with an extremely slight refractive power. These so-called waves are lines of irregular refraction in the air due to non-uniform density. The irregularities in density are due, I am convinced, to irregularities of temperature.

"Bearing in mind the foregoing facts in regard to the constant presence of air waves which are only a few inches apart and have a measurable refractive power, it is no difficult matter to deduce the conditions under which certain apertures become preferable."

Professor Douglass' discussion will be concluded in next month's number, when he will point out some limitations of the larger sizes.—*A. G. I., Tel. Ed.*

The Heavens in January

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Jan. 7
At 10½ o'clock: Jan. 14
At 10 o'clock: Jan. 22.

At 9½ o'clock: January 29

At 9 o'clock: Feb. 6
At 8½ o'clock: Feb. 14.
At 8 o'clock: Feb. 21.

NIGHT SKY: JANUARY AND FEBRUARY

MERCURY is an evening star when the year begins and may be seen low in the twilight, especially about the 6th when he is farthest from the sun (19° 15′). He then draws in rapidly and passes through conjunction on the near side of the sun on the 22nd. Venus is still a morning star but is so near the sun that she is substantially invisible. Mars is a morning star, rising less than an hour before the sun, and is hard to see. Jupiter is well visible in the evening sky and is due south between 8 and 9 P.M. during most of the month. Saturn is a morning star but can be seen only late in the month, and then with difficulty. Uranus is an evening star in Pisces setting about 11 P.M., while Neptune is in Leo and comes to the meridian between 2 and 3 A.M. in the middle of the month.

The moon is in her first quarter at 10 P.M. on the 7th; full at 5 P.M. on the 14th; in her last quarter at 11 A.M. on the 21st; and new at 2 P.M. on the 29th. She is nearest the earth on the 15th, and farthest away on the 1st and again on the 28th. As she circles the sky she passes Mercury on the 1st, Uranus on the 7th, Jupiter on the 11th, Neptune on the 17th, Saturn on the 26th, Mars and Mercury on the 28th and Venus on the 29th.

Chemistry in Industry

(Continued from page 76)

be spot-welded, rolled, drawn, hammered, and formed with ordinary tools. The value of the new metal is about half that of gold.

Chemical Jingles

THE following chemical rhymes by Thomas Stephenson, reprinted from a recent issue of *Industrial and Engineering Chemistry* will amuse anyone who has experimented in chemistry enough to remember that:

1. Silver nitrate, $AgNO_3$, is extremely corrosive and blackens the skin.
2. Calcium carbonate, $CaCO_3$, neutralizes sulfuric acid, H_2SO_4 with the liberation of carbon dioxide gas, CO_2.
3. Potassium cyanide, KCn, is a violent poison.
4. Copper sulfate, $CuSO_4$ comes in bright blue crystals.
5. Ammonium iodide is very explosive.
6. HgCl is calomel. $HgCl_2$ is bichloride of mercury.

Sam put $AgNO_3$
  In his ma's perfumery,
Thinking he would make a hit
  If he strengthened it a bit.
Now each morning little Sammy
  Goes to greet his Coal Black Mammy.

Johnny, feeling life a bore,
  Drank some H_2SO_4;
So his father, an M.D.,
  Gave him $CaCO_3$.
Johnny's neutralized, it's true,
  But he's full of CO_2.

Maudie was delighted when
  She found a lump of KCn.
"Daddy's fond of sweets," said she,
  As she dropped it in his tea.
Father drank it; that is how
  Maud's mamma's a widow now.

Tommy, eager to explore,
  Found some $CuSO_4$.
"Nice rock candy," Tommy cried
  As he jammed a lump inside.
Doctor pumped him out, it's true,
  But Tommy still feels rather blue.

Bobbie, in his careless glee,
  Mixed some I with NH_3.
When the stuff was dry and thick,
  Bobbie hit it with a brick.
Robert's now in heaven, they say;
  At least he seemed to go that way.

Auntie Jane gave Baby Sue
  A dose of $HgCl_2$.
Baby's with the angels now,
  And Auntie Jane is wond'ring how
A single atom of Cl
  Can make such change in calomel.

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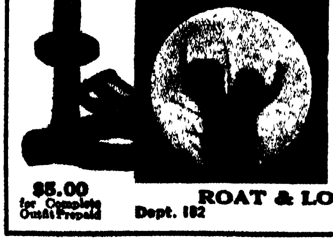

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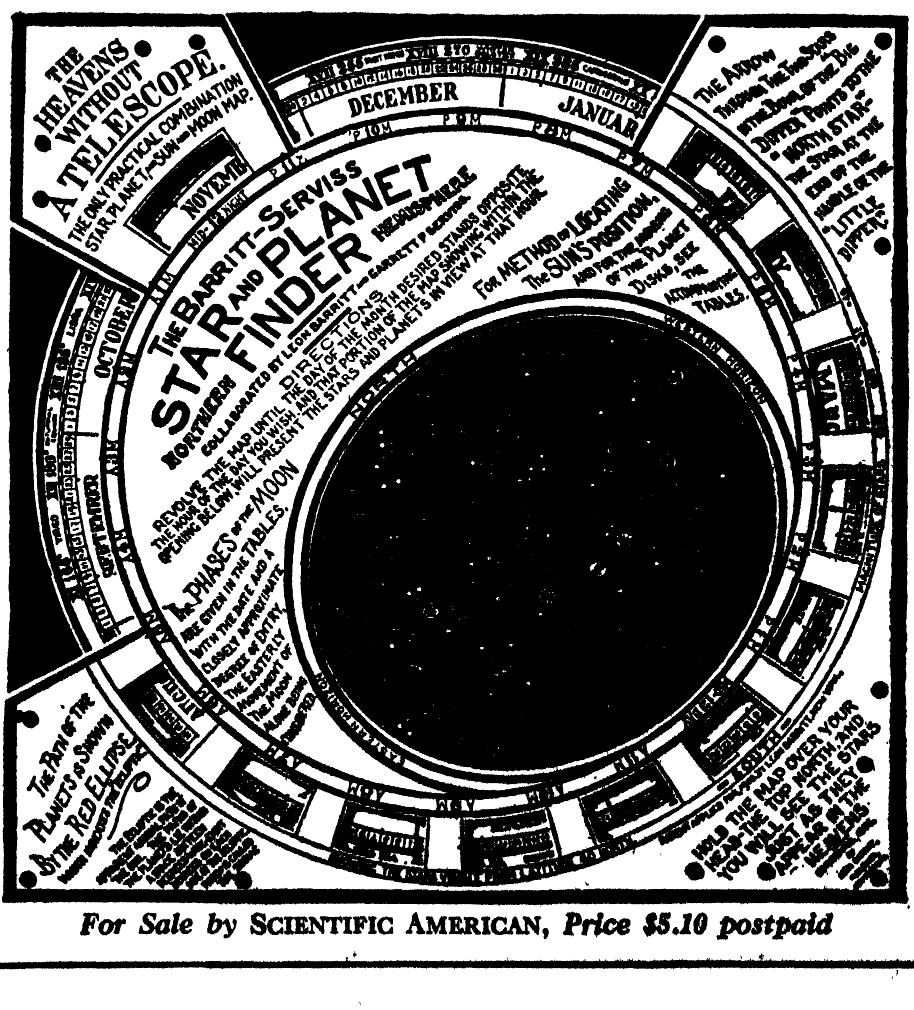
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content. But the general subject of ash in coal is no joke, economically, for millions of dollars are paid in freight to haul the ash which is part of America's coal.

The handling of the worthless ash through the various steps in the distribution and utilization of coal is a large item in the cost of energy delivered at the power plant, says the United States Bureau of Mines in a recently issued bulletin. For example, 1 percent of excess ash in a 50-ton car of coal amounts to 1000 pounds of worthless material per car and entails a loss in transportation cost of one dollar per car where the freight rate is two dollars per ton. If we assume an average freight rate of two dollars and forty cents per ton on the annual production of bituminous coal in the United States during 1927, the transportation loss amounts to a total of 12,426,000 dollars for each 1 percent of unnecessary ash. Consideration of this one item alone shows the economic importance of dirt in coal.

The froth-flotation process, used extensively in the concentration of ores, has been applied within recent years to the separation of coal from ash-forming materials. Briefly, the process involves the agitation of raw coal, 1/10-inch in size or finer, with four to ten times its weight of water and a small quantity of reagent (0.5 to five pounds per ton of dry coal). The reagent with air forms a froth supporting the coal, which floats at the surface and may be removed, while the ash forming materials are largely rejected and remain in the bulk of the water and may be removed separately.

Many reagents may be used including certain oils, soluble organic substances, alcohols, and soaps. The process appears to be particularly applicable to coal that is originally fine or that is crushed to fine size as a part of normal preparation treatment, as for coking.

New Uses for Stellite

STELLITE, a cobalt-chromium-tungsten alloy, has been known as a cutting-tool alloy for many years. Now, due to the development of the Stelliting process, it is finding wide use in a comparatively new field, namely, resistance to wear or abrasion and to combined abrasion and corrosion, says W. A. Wissler, in a recent issue of *Chemical and Metallurgical Engineering*.

The demand for faster production and longer life for all machine parts subject to abrasion has resulted in the development of the hard-facing process, which consists in welding a surface of a wear-resisting alloy to an iron or steel base. This process produces a composite article having a surface of highly specialized alloy capable of resisting abrasion, combined with a steel or iron base that has ample strength and toughness to support the wear-resisting surface.

Such a composite part has great economic advantages as it will wear much longer than a solid steel or iron part and is much stronger and cheaper than if it were made entirely of the wear-resisting alloy. The process also permits the rebuilding of worn parts, thus extending their life indefinitely.

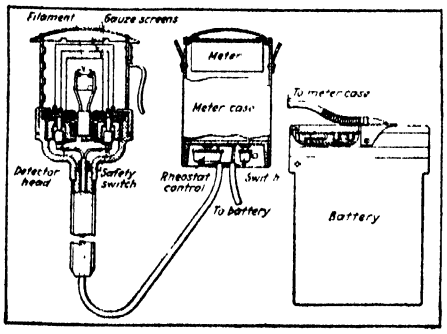
Stellite is being extensively used in many of the large industries wherever severe abrasion is encountered. Included are agricultural machinery, rock drilling and digging equipment, and dies for metal-forming operations. The paint industry uses this alloy on grinding and pulverizing machinery. Cement and cement clinker are both ground and conveyed with the help of Stellite. The active surfaces of colloid mills are being hard-faced with this alloy, as is also grinding and crushing equipment of all kinds.

Electric Tester Shows Presence of Inflammable Gas

A NEW electrical tester used for determining the presence and amount of inflammable gases, was described in this department in our June 1929 issue. More detailed information is now available, showing how the detector operates. The device makes use of a heated metallic filament connected in one arm of a Wheatstone bridge circuit. Its use is based upon the fact that the burning of a combustible gas on the surface of a heated filament causes an increase in the temperature of the filament and consequently an increase in its resistance. If, when the bridge is in balance, the filament is exposed to a combustible gas-air mixture, the resultant combustion throws the bridge circuit out of balance, and current flows through the galvanometer, causing a deflection of the needle. The magnitude of this deflection is dependent upon the concentration of the combustible component.

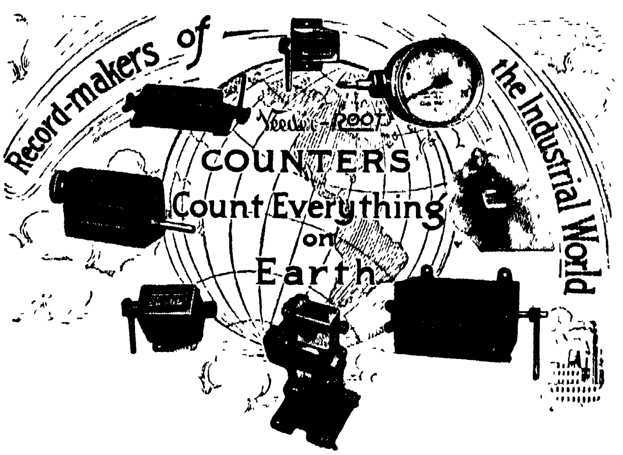
The illustration shows the apparatus partly in section. The detector head consists of a cylindrical metal case or bonnet, in which are three concentric, cylindrical gauze screens of a type similar to those used in flame safety lamps. These afford protection against ignition of an external gas-air mixture.

In operation, for instance in the detection of methane in mines, the operator first turns the switch to heat the filament. Then after a few minutes, when the filament has reached a temperature equilibrium, he connects the meter in the circuit. This is done while the detector head is in a vertical position in pure air. The rheostat knob is adjusted until the meter reads zero, after which the detector may be inserted into the atmosphere to be tested.



Interior mechanism of electrical tester for determining the presence of dangerous gases in the atmosphere

The atmosphere will penetrate the gauze screens and come in contact with the hot filament, whereupon, if any methane be present, the meter needle will immediately move and come to rest at a point indicating the percentage. If the gas mixture is of explosive proportions, the needle will move rapidly back and forth across the upper part of the scale, this oscillation indicating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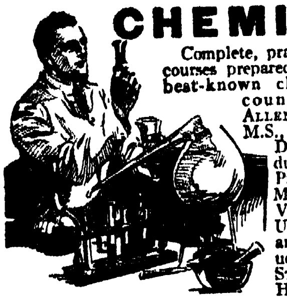

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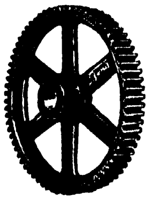

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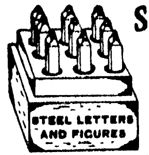

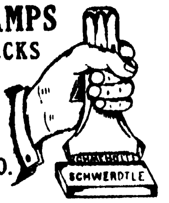

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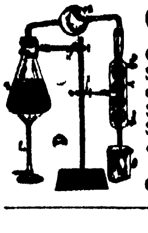

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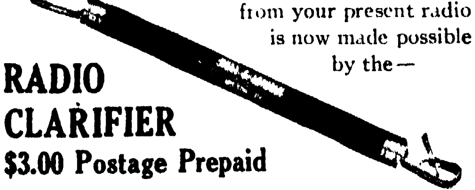

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recurring explosions within the inner screen which cause periodic cooling and heating of the filament.

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Phenol Prevents Mold on Leather

It is a common experience to find mold on the surface of leather goods that have been stored away, particularly if the storage place is warm and damp. This tendency has caused no little trouble to shoe manufacturers because the growth occurs on sole leather during the process of manufacture.

In efforts to prevent this nuisance, the United States Bureau of Standards chemists have discovered that if the leather is soaked in a 0.2 percent solution of phenol, no mold forms. This simple expedient suggests that phenol or some phenol salt might be used to advantage in dressings for use on leather which is apt to mold in storage or in use, because of high humidity due to climatic or service conditions.

Learning to Use Our Wings

(Continued from page 73)

tion is the resistance of the dead propeller. Generally speaking, the propeller runs as a windmill and turns the engine over. The resistance is then much greater than when the propeller is completely stopped, because the power to turn over the propeller and the engine is obtained from the stream of air.

If the propeller is free to revolve and is disconnected from the engine, the resistance is smaller than that of the completely stopped propeller and much smaller therefore than the resistance of the propeller when turning the engine. There are two solutions available: to lock the propeller so that it cannot turn, or to fit it with a "free-wheel" mechanism. The latter and more effective solution is being tested experimentally. It constitutes a pretty mechanical problem.

European constructors are now following American practice in the matter of wheel brakes. One aspect of wheel brakes, which we have often discussed, is the possibility of turning over if the brakes are applied violently and the wheel center is not far enough forward of the center of gravity of the airplane. If on the other hand, the wheel is put well ahead of the center of gravity there is some difficulty in raising the tail at take-off. French designers are now meeting the difficulty by arranging an automatic brake release operative when the tail of the airplane rises. We hope to present shortly a description of this interesting device.

The main objectives of French effort are now safety in flight, the development of

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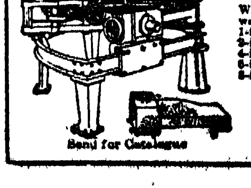

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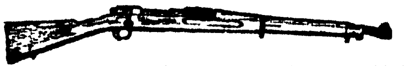

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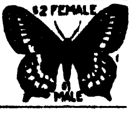

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commercial aviation, and improvement in metal construction. These objectives are akin to those of American aviation.

It is always troublesome and expensive to protect steel aircraft members against corrosion by the use of paints, varnishes, and and similar preparations. The British have apparently solved the problem by the electro-deposition of zinc and cadmium on steamline wires, tie rods, et cetera. They are also using stainless steel in their structures, with much success.

In American practice, the guiding of aircraft by radio has been accomplished by the projection of a radio beam, deviation from the path of which is indicated by a visual or audible signal to the pilot. The British have been more interested in giving an airplane its exact bearings. The system employed consists in having two or more direction-finding stations on the ground, which on demand from an aircraft take a bearing on the aircraft. These stations are usually grouped under a common control where the bearings obtained are correlated and the position of the aircraft determined and transmitted to the pilot. This system offers the objection that it requires the aircraft to be equipped with both a transmitter and a receiver and needs a certain amount of formal signal organization.

Now as a result of considerable research, a system has been developed which requires only a receiver on the aircraft and enables the plane to determine its position wherever it may be, provided only that it is within the range of the transmitter. The system employs on the ground what is termed a rotating beacon. This is a transmitter consisting of a simple loop. This loop is rotated at a constant speed of one revolution per minute. It transmits a characteristic signal when in the north and in the east positions.

If the aircraft pilot receives the north signal from the beacon and notes the time which elapses between the transmission of this characteristic signal and the receipt of the minimum signal, the bearing of the aircraft from the beacon is immediately obtained by multiplying the time in seconds by six. An installation consisting of two such beacons enables the plane to determine its position without having to transmit. The system is simple and requires no preconcerted signal organization.

Such a system might have considerable advantages over the American plan.

Beryllium for Aircraft

At the meeting of the Society of Automotive Engineers held during the Cleveland Air Races, the possible use of beryllium for aircraft construction was discussed. This is a most extraordinary metal. Its density is only that of magnesium or about two thirds that of aluminum, yet in strength and elasticity it is equal to steel. A 60 percent beryllium-aluminum alloy may have a tensile strength of 60,000 pounds per square inch and beryllium, if used for aircraft construction, has extraordinary possibilities of weight saving. One competent authority estimates that a Ford tri-motor plane could be lightened over a thousand pounds by the use of this new metal. Its main drawback is cost, which is now about 60 dollars a ton. If this can be reduced, particularly by sale of the by-products of beryllium ore, this material may become immediately useful to aircraft designers.

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

"Eskimo Pie" Patent Held Invalid

DESPITE the fact that "Eskimo Pie" had achieved almost phenomenal success commercially, having a marked effect upon the ice cream and confectionery industries, it has been judged unworthy of protection under the existing patent. This decision, rendered by the Circuit Court of Appeals for the Third Circuit, upheld the ruling of the lower court that there was no invention in coating a block of ice cream with chocolate.

The holder of the patent, Eskimo Pie Corporation, had brought suit for infringement against John Levous and Purity Ice Cream Company in the District Court for the District of New Jersey. The defendants admitted that if the patent were valid it was infringed, leaving the court to decide upon the question of validity.

In holding invalid the patent granted to C. K. Nelson (Number 1404539) in 1922, for a chocolate covered rectangular block of ice cream, the court gave credence to earlier references which described the manufacture of "ice cream cannon balls" These confections were round balls of ice cream covered with chocolate in the manner that candies are coated. The appellant contended that the Eskimo Pie coating is a "sustaining and form-retaining casing," unlike the coating used for the "cannon balls" and candies. In the opinion of both courts, this claim was not substantiated and there is no invention in merely changing the shape or form of an article without changing its function, except in a design patent.

In a doubtful case of this kind, the fact that a patented article has gone into general use has great weight, but in this instance it was held that commercial success is an unsafe criterion even of utility and much less of patentability. It was pointed out that such success may be due to extensive and judicious advertising, activity in putting the goods upon the market, large commissions to dealers or the attractive manner and form in which the goods are put up and exposed to the eyes of the purchasers. Moreover, the court decided, when an article is sold under a trademark, commercial success may be due to a large extent to an attractive name used as a catch word.

New York courts are apparently more charitable than New Jersey courts, for in the somewhat analogous case concerning the process for making ice cream lollypops, the genius of the inventor is recognized. In the latter case, the District Court for the Southern District of New York ruled that the Burt ice cream lollypop (Patent Number 1470524) was valid and infringed. The Popsicle Corporation et al had brought suit for infringement against Isadore Weiss, doing business as Goody Frozen Products Company.

Various patents were citied in an attempt to show that the Burt patent was lacking in patentable novelty. One of these was a patent to Goldberg (60136) in which a stick was inserted into candy while the candy was in a warm, soft, sticky condition: upon cooling, the stick became rigidly fixed to the candy. However, the Court upheld the Burt patent, stating, "It is one thing to insert a stick in a warm, soft, sticky substance that by cooling will adhere thereto, and quite another to effect a strong union between a stick and frozen substance." Other prior patents had disclosed a handle of metal and a flexible looped cord frozen into a block of ice cream, but they were held not to anticipate the use of a wooden stick.

Motion to Dismiss With Prejudice Denied

IN the suit of A. C. Gilbert Company *versus* United Electrical Manufacturing Company, in the District Court for the Western District of Michigan, the court denied a motion for dismissal of the bill with prejudice on the grounds that the case must be settled on its merits. Both firms are manufacturers of electrically operated devices, which are used for the same purposes and are sold by plaintiff and defendant in competition. The plaintiff filed a bill of complaint and then sent circulars to the trade and to the defendant's customers, asserting that the defendant's devices were infringements on patents of the Gilbert company.

Later the plaintiff filed suit against one of the defendant's customers in another jurisdiction, and desired for convenience to try the matter at the latter place. With this end in view, the plaintiff filed a motion to dismiss without prejudice the original suit. The motion was opposed by the defendant on the ground that in view of the publication of charges asserting infringement, a prejudice was left in the minds of defendant's customers without opportunity on his part to disprove the charges.

In its decision, the court held that the publicity given the matter must have had a detrimental effect on the business of the defendant. In the opinion of the court, "this effect is of such nature as would not be removed if the bill of complaint herein be voluntarily dismissed. . . . Such damage to defendant's reputation and business standing can only be removed by a judgment of the court deciding the controversy on the merits." The court held also that the defendant cannot use the conduct of the plaintiff as a ground for dismissal of the bill with prejudice while relying on such conduct as a ground for opposing the dismissal of such bill without prejudice.

White Light from Electrified Gases

SINCE George Claude produced light with the first practical electrified gas-filled tube, utilizing neon gas, engineers have been seeking to perfect an optically clear white light of the same type as the red light produced with neon. The principal difficulty has been to produce a gas yielding a white light, having sufficiently long life to be commercially practical. Engineers of Claude Neon Lights, Incorporated, have developed what seems to be the desired white light, possessing the characteristic brilliance of electrified gaseous light without imparting glare or eye strain.

It is contended by the advocates of luminous tubes that the ordinary electric incandescent lamp incurs a waste of more than 75 percent of the electric current, because of the heat that must be generated before the filament provides illumination. In the gaseous tube type of electric light, advantage is taken of the fact that the inert gases of the atmosphere are conductors of electricity, and consequently an electric current can be passed through a gas-filled glass tube without the use of wire filaments. The action of electricity on the gas creates the luminous glow which has become so familiar in advertising displays. This glow can be controlled in density and color.

The new white light is said to render greater visibility with less actual candlepower than is required when using incandescent lamps, with considerable saving in electric current consumption. Because it is a comparatively cold light, it is said to be adaptable to under-water illumination and various cold weather conditions. The new white tubes possess brilliance and intensity comparable with tubes of red, blue, green, yellow, and other colors.

Just the Inventor

AN engineer, explaining the operation of a certain machine in a factory, was very much annoyed by the frequent interruptions of a certain man. Exasperated, the engineer refused to continue and walked away.

"Who is this fellow who pretends to know more than I do about this machine?" he demanded, when he met his employer.

"Oh, he is the man who invented it," was the reply.

Patents in Czechoslovakia

NUMEROUS aeronautical patents have been issued recently in Czechoslovakia, including one (Number 26383) which enables an airplane, in the event it alights on steep ground, to be protected against tilting over. Another (Number 25798) makes it possible to secure the simultaneous release of an airman and parachute by merely pulling a lever, which frees the parachute so that when the airman jumps the 'chute is pulled away from the plane, opening automatically. Patent Number 25809 facilitates the opening of the parachute at the moment when the flyer jumps from the airplane.

According to a report compiled by Dr. Kunzl, Departmental Chief of the Patent Office of Czechoslovakia, the applications for patents received during 1928 numbered

8461 or 698 more than in 1927. The number of new patents granted in 1928 was 3450. Every year sees an increased interest in the protection afforded by patents. Many of the applications come from the United States, which ranks next to Germany in the number of foreign applications received. Electrical machinery and equipment, chemical processes, and various kinds of apparatus are the most popular fields for invention, according to the report of Dr. Kunzl.

As in other parts of central Europe there has been a marked increase in popular interest concerning new technical developments during the past few years, although the world-famous Czech handicrafts are still flourishing, providing a livelihood for thousands of impoverished families. An association known as the Detva is active in keeping alive the peasant customs and folklore of a people who can look back upon a thousand years of history and tradition, and the Red Cross has provided funds for Czech children in the schools to be taught how to make toys, ornamental beads and small wooden figures which find a ready market in Europe and America. The Red Cross hopes to enlarge this work to teach the children to make embroidered bags, laces, and ornamental lamp shades, for which there is a constant demand. In some of the mountainous districts where most of the adults eke out a living as weavers and glass makers, the children have been able to provide themselves with excellent schools largely through the money they have earned by pursuing their native handicrafts.

British Inventor Perfects Message Recorder

LOUIS BLATTNER, noted for his invention of the magnetic steel wire system of recording "talking pictures," which is said to produce records that are virtually everlasting, has perfected a telephonic recording machine which is said to automatically record and file telephone conversations or communications. The record is available as soon as the conversation ends. It is pointed out that telephonic messages can be received and recorded late at night without disturbing friends, or at places of business outside of working hours. The patents are held by the London Blattner organization and the Telegraphic Patent Syndicate of Berlin, which joined forces recently under British control.

Fire Extinguisher Patent Not Infringed

ACCORDING to a ruling issued in the case of Foamite-Childs Corporation versus Pyrene Manufacturing Company, the Laurent patent now owned by the plaintiff has not been infringed by the defendant's apparatus used for the same purpose, which is not constructed with a mixing chamber within the device. The case was an appeal from the District Court for the District of Delaware, in which the plaintiff had brought suit against the defendant charging infringement of United States letters patent 858188 issued to Mr. A. G. Laurent of Russia, on June 25, 1907. As the bill was filed in 1924, only a few weeks before the patent expired, the plaintiff did not seek an injunction.

Although the plaintiff in his suit for infringement of the patent claimed otherwise, the court held that the claims in suit were limited to chemically operated foam entinguishers which, although perhaps not having mechanically complete mixing chambers, nevertheless are constructed with a chamber sufficiently complete to enable the apparatus to operate as described in the patent. In reaching this conclusion, in was held that although the claims not in issue include, in terms, a "mixing chamber," and the claims in issue do not include such terms but state that the substance is mixed, the claims in issue must be limited to include a "mixing chamber" to avoid the prior art. Judge Buffington dissented to this view.

It was also stated that where claims do not specifically call for a "mixing chamber," they may be interpreted to do so when the specification states that a mixing chamber is essential. In his dissenting opinion, Judge Buffington pointed out that the distinguishing feature of both extinguishers is the fire-blanketing foam, that the plaintiff was the only maker in America of such apparatus until 1922, and that the defendant began making and selling foam extinguishers in 1922, two years prior to the expiration of the Laurent patent. The Pyrene company had been previously selling soda and acid extinguishers in competition with the foam-producing apparatus. The proof offered in the suit showed that the older type of extinguishing equipment has been completely superseded by the foam extinguisher. In stating his reasons for believing that the patent should be held valid and infringed, the dissenting judge cited the fact that the Laurent invention is embodied in a generic claim as follows:

"A fire-extinguishing apparatus, comprising a receptacle containing separated gas-producing fire-extinguishing substances and a foam-producing substance which causes the substances to produce a gas-filled foam simultaneously with the evolution of gases."

In centering the case around the mixing chamber necessary for the production of fire-extinguishing foam, the Court of Appeals sustained the decision of the district judge, who had dismissed the bill of complaint on the ground that the Laurent patent was not infringed because the claims in suit must be limited to chemically operated foam extinguishers. Such extinguishers, although perhaps not having mechanically complete mixing chambers, nevertheless are constructed with a chamber sufficiently complete to enable the apparatus to operate as described in the patent. The defendant's apparatus was not so constructed, according to the Court, and consequently there was no infringement. The dismissal of the bill was affirmed.

Sanitary Robot Vends "Hot Dogs"

PATENT 1716266 has been granted to Alexander Flamm of Bridgeport, Connecticut, for a vending machine which cooks and seasons frankfurters, places

Patents Recently Issued

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Pertaining to Aeronautics

LONGERON FOR AEROPLANES—Formed from four metal tubes connected by means of rigid struts and wire diagonals with adjustable tension, the lines of action of stress all passing through the central axis which serves to support the strut. Patent 1731157. Gianni Caproni.

AIRSHIP CONSTRUCTION—Wherein the wings are disposed in somewhat compact form adjacent the propellers thus obviating the additional weight created by outspreading wings, and aiding in lifting the ship which may be automatically righted without aid of the motor power. Patent 1731348. Marshall R. Myers.

AIRCRAFT LANDING—Wherein mechanism, including a hooking device, at the top of the aeroplane is caught by a cable suspended between two captive balloons and the aeroplane subsequently lowered to the ground without being subjected to damaging shocks. Patent 1731091. Harr C. Belleville.

AEROPLANE—Constructed with means under the pilot's control for dropping the engine and gas tank in case of necessity, and releasing parachutes connected with the fuselage so that the plane and its occupants may be brought in comparative safety to the ground. Patent 1733030. Morris D. Rosenblum.

Pertaining to Apparel

ARCH SUPPORT—Embodying a metallic plate interposed between the inner and outer sole of a shoe for holding the inner sole in such form as to embrace the arch and support the metatarsal bones of the foot. Patent 1731106. William D. Moore.

COLLAR PIN—For holding soft or semi-soft collars, wherein the front bar of the pin has a necktie receiving recess which will prevent the necktie from being pushed outwardly, as is the case with a straight pin. Patent 1731163. Stanley L. Gedney.

STRAW HAT CONSTRUCTION—In which a mechanical or non-adhesive means is employed for securing down the pointed projections of straw braids in flat contact with the next adjacent convolution, whereby a lighter and more flexible hat is produced. Patent 1733075. Philip Rosenberg and Albert Jaeger

Chemical Processes

METHOD OF WATERPROOFING FABRICS—Wherein cloth is given a coating of pyroxylin, which is a solution of nitrocellulose, solvent, plasticizer and gums, on one side, subjected to a finishing action, and treated with a second pyroxylin coating, which leaves it flexible. Patent 1732121. Kenneth B. Church.

ALKALI-METAL COMPOUND OF A SUB-OXIDE OF TITANIUM AND DERIVATIVES THEREFROM—Sodium orthotrititanite—a new alkali metal compound of sodium and titanium in which titanium exists as a sub-oxide $Ti_3 O_5$. One of its forms is dense bluish colored powder unsoluble in but hydrolyzed by water. The formula being $2Na_2 OTi_3 O_5$. Patent 1731364. Foord von Bichowsky.

Process for Recovering Borax from Brine—More particularly the brine of Searles Lake, California, whereby it is possible to obtain carbonates of soda in the form of large crystals, easily separated from the mother liquor, and quickly washed clear of adhesive brine. Patent 1733537. Henry D. Hellmers.

Designs

Design for a Paper Napkin or the Like—Patent 79610. Edwin B. Schoonmaker.

Design for a Fabric—Patent 79599. William H. Mayer.

Design for a Hub Cap—Patent 79653. George L. Hall.

Design for a Combined Lamp, Ash Tray, and Lighter—Patent 79656. Charles W. Hopes.

Design for a Radiator-Cap Ornament—Patent 79550. George A. Briggs.

Design for a Radiator Cap—Patent 79718. Fred A. Holloman.

Electrical Devices

Electric-Light Fixture — In two parts, one of which may be secured to the stud at the outlet, the other providing some freedom of movement between the body of the fixture and the part secured to the stud. Patent 1732087. Richard Hammerly.

Of Interest to Farmers

Hog Greaser—Which is simple in construction, yet rugged and durable in use, may be readily charged with grease, and in which a positive feeding of grease against the bodies of the hogs is assured. Patent 1731181. William E. Shimp.

Agricultural Machine — A cultivator or harrow especially adapted for use with an attachment, to Ford tractors, for cultivating the soil beneath low branches and close to the trunks or main stems in orange groves or orchards. Patent 1731925. Levi C. Hester.

Fruit-Gathering Device—Consisting of a pair of cutters and a receptacle, the cutters being so constructed as to be operated by one hand, and automatically sharpening themselves, the receptacle may be readily emptied, particularly adapted for gathering cherries. Patent 1732252. Amasa O. Blue.

Of General Interest

Ventilating Awning—A Venetian blind which may be raised and lowered to desired positions, and the slats manually operated and adjusted to various angular positions for any degree of ventilation. Patent 1729928. Charles L. Dabney.

Concrete Wall Construction—In which special slabs two inches in thickness are secured in vertical relation edge to edge and locked into reinforced concrete columns poured in place, easier to erect, and cheaper than solid concrete, for certain purposes. Patent 1729293. Charles E. McCartney.

Holder for Graphic Instruments—Adapted for holding a fountain pen or other closely analogous instrument conveniently disposed in an angular position, the holder will accommodate and yieldingly or tensionally hold pens of different sizes. Patent 1730287. Ernest Oldenbusch.

Book Cover—Particularly adapted for account books, to protect them from the usual wear and tear, the cover is provided with means whereby a metal plate may be applied to serve as a hard writing pad. Patent 1730244. Rudolf Reinisch.

Universal Plug Valve—So called because it can be made to replace any type valve, and will prevent leakage or escape of fluid, gas, liquid, etc., no packing being necessary and no extra space necessary in operation. Patent 1730305. George Stancu, Jr.

the "weenie" in a toasted roll which is automatically slit, and transfers the sandwich to a sanitary wrapper which mechanically closes around the contents. The chief claim for the device is that it keeps the food free from dust. The machine is controlled by electricity, and is operated by the insertion of a coin.

Origin of Our Patent and Copyright Laws

Delving into Colonial and early American history, according to Karl Fenning in a recent issue of the *Journal of the Patent Office Society*, one finds that there was no debate or controversy concerning the patents and copyrights clause of the Constitution. According to Mr. Fenning, the patent statutes and the copyright laws of the United States are based on a section of the Constitution which does not employ either of the words "patent" or "copyright" but reads as follows:

"The Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

General Charles C. Pinkney of South Carolina played a leading part in having the Constitutional Convention authorize protection for both authors and inventors. As early as 1784, South Carolina enacted a statute for protecting inventions. Prior to this time, according to Mr. Fenning, there had been several states with copyright laws but none that had made provision for patenting inventions. After providing for copyright protection of books, the South Carolina Act said:

"The inventors of useful machines shall have a like exclusive privilege of making or vending their machines for the like term of 14 years, under the same privileges and restrictions hereby granted to, and imposed on, the authors of books."

Of course, it is pointed out by Mr. Fenning, "copyright and invention patent protection was extended to the colonies by the English laws, and the meaning of the words 'patent' and 'copyright' were more or less fixed. The laws of five of the States, namely, Connecticut, Georgia, New York, and North and South Carolina, had definite requirements for publication of copyrighted books in sufficient numbers and at a cheap enough price to satisfy the public demands.

"Those requirements were, of course, impressed upon the patent clause of the South Carolina statute, and apparently became a requirement to manufacture the patented device and to sell it at a reasonable price. Some of the state laws provided that if these requirements for publication and sale were not carried out a tribunal might grant a license to someone else to publish.

"It is significant, therefore, that in framing the Constitution in its final form, the words patent and copyright were not used, possibly lest the power be limited to the particular forms of conditional exclusive rights which were at that time known as copyrights and patents. The words finally chosen for the Constitution seem to allow no limitations on the 'exclusive' right such as requirements for working or compulsory licenses. It seems clear that it would be unconstitutional for Congress to endeavor to provide for either type of limitations in either patents or copyrights."

Joint for Corrugated Boxes—Especially designed as a corner connection for a box of the foldable type, to be employed in lieu of connecting the meeting edges with a strip of tape which is the common practice. Patent 1731111. Morris C. Romer.

Glass Protector for Windows and Doors—In the form of a metal strip with reinforcing pad, which may be quickly applied to the surface of plate glass windows for protecting the glass in cases of severe wind storms. Patent 1731114. Martin E. Sparrow.

Rod-Supporting Means—For awnings and canopies, a union consisting of rod end receiving sockets for connecting together the sections of an unusually long rod and rigidly supporting and preventing sagging of the same. Patent 1731113. Fred W. Siegel.

Recording Device for Cameras — Which will operate in conjunction with the shutter for photographically registering on a portion of each film or plate certain information, such as time of exposure, and "stop" used, which will appear when the film is developed. Patent 1731198. Frank J. Kawatch.

Reflecting Device for Motion-Picture Projectors—Whereby an adjustable auxiliary reflector, added to the main reflector, will enable the operator to simply and efficiently control the distribution uniformity and intensity of the light with accuracy as it is projected on the film. Patent 1731104. William Mayer.

Ring Setting—Having a mounting with swiveled connection which permits the setting to be reversed to expose different stones, the setting also being hinged between the stones or ornaments so that it may be opened to expose a picture or other enclosure. The inventor has been granted two patents, 1731092 and 1731190. Charles Birnbaum.

Toothbrush—Having brush head sections which may be converted from a convex surface to a concave surface, or vice versa, the brush head being held by a latching means. Patent 1731751. William M. Neissl.

Nursing Bottle—So constructed that air will enter at the bottom instead of at the top thus causing an easy flow through the nipple, leakage being prevented through a valve. Patent 1732126. Joseph P. Gardiner.

Collapsible Barrel—Wherein a plurality of hingedly connected sections may be readily disconnected, permitting storage in a limited space, the barrel may be readily assembled or dismantled without the use of special tools. Patent 1732128. Harley A. W. Howcott.

Humidifier—Constructed to utilize the waste heat from the smoke pipe of a heating plant to warm and vaporize a spray of water for producing the proper moisture into the air of a home or other building. Patent 1732055. William P. Lee.

Internal Control for Dumb-Waiter Doors—Which will prevent the occupants of apartments opening and leaving open the door, which becomes a source of great danger, the door opening only on signal from the janitor that the elevator is at the apartment floor. Patent 1731349. Holger Petersen.

Guard for Gutters—In the form of a screen for roof gutters, or eaves troughs, for preventing leaves and rubbish from entering the gutter and clogging the drain pipes, and so preventing the same from overflowing. Patent 1732058. Martin M. Martini.

Type Clamping Attachment for Chases—In the form of a bar attached at its opposite ends to one side of the chase, and elements threaded through said bar for clampingly engaging the type, and relieving the chase side of warping strains. Patent 1732074. Andrew B. Weiler.

High-Light Stop for Cameras—A light stop plate having grouped light openings assembled in polygonal formation with opposite corners of a diagonal of the figure disposed in the longitudinal median line of the plate. Patent 1732051. Carl G. Johnson.

Shower-Bath Spray—Wherein hot and cold water are delivered simultaneously, through separate pipes, so that the water strikes the body in the form of a hot stream encircled by a stream of cold water, giving a very exhilarating shower. Patent 1733054. Edgar J. Crill.

Envelope Opener—In which, through the co-operation of two blades, the extreme edge of an envelope is cut away and separated from the body so as to cause the envelope to be opened along an entire edge. Patent 1731418. Richard Glasser.

Corrugated Roofing and Building Sheet—Comprising a duplex corrugated sheet formed by uniting two separate preformed sheet elements, the outer one being of asbestos cement and the inner of compressed cork-board sections, the two being cemented together by a jointing cement. Patent 1732368. Louis Lane.

Educational Device—Comprising an alphabet display means, having the consonant letters and the vowel letters colorably distinguished from each other, to aid in or otherwise facilitate the teaching of correct spelling and increase the average individual vocabulary. Patent 1732980. Althea S. Mooney.

Container—Having a restricted tubular member with closure, in open communication with the container, through which material may be removed from the container while preventing too great a surface of the contents being exposed to the atmosphere. Patent 1733889. John Laughlin.

Insect Trap—Or catching device, which has conically shaped members open at opposite ends, which will aid in guiding an insect into a chamber, divert it away from the original passage it entered and prevent its escape. Patent 1733818. Carl J. Nordstrom.

Crutch—Having a resilient tip or bottom, the resilient features consisting of a spring, a rubber ball and a cylindrical sleeve for holding both the ball and spring in conjunction with one another. Patent 1733430. John L. Shahan.

Heating and Lighting

Damper Control—In which a manually operated wheel revolved through a complete revolution will move the damper through a small angular degree to give a minute draft control, and will maintain the damper in any desired position. Patent 1733832. Charles H. Sparklin.

Hardware and Tools

Pipe Cutter—Having means for advancing the cutter, for cutting pipe or other cylindrical objects, during the act of turning the stock upon such objects, thus, in effect, bringing continuous cutting pressure to bear. Patent 1732160. Richard T. Frye.

Cable Clamp—Including a cable-receiving body member having bifurcated portions which are adapted to receive a clamping member which is adapted for threaded engagement to control the tension applied to cables received therethrough. Patent 1732033. Edwin B. Snead.

Nut Lock—Which may be applied to any standard bolt, thereby dispensing with specially constructed bolts, means being provided and actuated by the rearward rotation of the nut for firmly locking the same against such rotation. Patent 1731337. Sebastian Giovannini.

Pipe Wrench—Which has a positive and instantaneous grip, great freedom of release, and is adapted to be instantaneously reversed without taking it off the pipe, a locking notch preventing any accidental loosening from the pipe. Patent 17456. (Reissue.) Oscar Johnson.

Cable Fastening—A strong and durable fastening device which will securely anchor a cable to a post and permit the former to be subjected to a maximum strain without becoming detached, yet in case of breakage of any one of the elements they may be quickly replaced. The inventor has been granted two patents, 1732053 and 1732054. Omar K. Landis.

Adjustable Ratchet Wrench—Adjustable to suit a variety of objects such as nuts, wrench sockets, square or other bars, is adaptable to all the standard sizes of sockets so that it may be regarded as a universal handle. Patent 1733012. William F. Henderson.

Machines and Mechanical Devices

Grinding Machine—Particularly adapted for boring or reboring the cylinders of engines, which can be secured to the cylinder, by the same bolts which secure the cylinder head, and attached in place of a cylinder head. Patent 1729288. Frank S. Harrell.

Alarm Mechanism for Clocks—Which first renders operative a relatively mild alarm and signal light to gently awaken the sleeper, and subsequently sets into operation an alarm bell, the device may be conveniently associated with many conventional alarm clocks. Patent 1730276. August J. Kollman.

Tire - Patch - Cutting Apparatus—A belt-knife splitting machine, which facilitates the making of tire patches from old and used tires, and forms the patches uniformly, accurately and quickly, and insures patches of perfect shape for tires or other articles. Patent 1731132. Adolph R. and Charles Hendry.

Pump Plunger—Adapted for pumps employed in mines for removing water and other liquids, wherein the main part of the plunger is formed of vitreous material and the metal parts formed of acid resisting metal. Patent 1731147. Fred W. Moyer and Frank J. Reninger.

Derrick Cap—Which will adjust itself to the pull of the guy cables without causing any binding between the cap and gudgeon pin, will permit the mast to swing in any direction, and may be repaired without dismantling. Patent 1731121. Edward P. Bathurst.

Drill Stem—For use with well equipment, will stand a maximum of vibration, comprises telescoped tubes and a threaded head at each end, each having connecting means with the drill stringer and the drill bit. Patent 1731171. Jesse P. Miller.

Cableway—An overhead travelling system that is capable of carrying loads and depositing them at any point within a prescribed three dimensional space, particularly adapted for use in the construction of dams and bridges. Patent 1729964. Verne L. Peugh.

Display Case—Having mechanism whereby lead pencils or other articles are attractively displayed and readily accessible for purposes of sale, or other authorized purposes, yet reasonably safe against removal by an unauthorized person. Patent 1732173. Sverre R. Svendsgaard.

Cutting Mechanism—The inventor has been granted two patents, for fabric cutting mechanism, one for cutting strips on the bias of predetermined length and width, and for protecting the cutter, the other having a cutter arranged for cutting a piece of fabric at any desired angle, within a certain range, into strips of various lengths and widths. Patents 1732148 and 1732149. William R. Barrett.

Hoisting and Transporting Device—A structure which is adapted to be set up over a hole communicating with a basement for hoisting cans of ashes or refuse from the basement and for transporting the loaded can to a disposal point. Patent 1732153. Delma C. Crichton.

Filling Mechanism—Adapted to dispose measured amounts of liquid, such as syrup, in bottles, the capacity of the measuring means may be varied to the slightest fraction of an ounce and the desired quantity disposed in each bottle, irrespective of the temperature effect upon the liquid. The inventor has been granted two patents, 1731464 and 1731465. James Kantor.

Method of Coating Pipes—Whereby the outside is conveniently covered with a waterproofing composition, such as bitumen or asphaltum, applied hot, and which sools to form a complete coating to protect the pipe from injurious contact with the earth. Patent 1733006. Hugh M. Cook and Lorlys R. Rogers.

Sod Cutter—A machine adapted to be drawn over sodded ground, having means for cutting the sides of the sod and beneath the same to a desired depth, and a knife for severing the sods in given lengths. Patent 1732972. Michael J. Kniffing.

Printing-Press Attachment—For stock feeding tables, whereby automatic suction shoes are prevented from bearing weight on the uppermost sheet and pressing it down upon the next sheet, designed for "Miehle" presses but may be slightly changed to fit other presses. Patent 1732653. Boliver Margwarth.

Electric Sand Sprayer—A spraying machine conveniently manipulated by hand, in which sand is discharged into a conduit wherein a forced draft thoroughly separates the sand, a tapered nozzle discharging the sand in a fine spray. Patent 1732655. Kurt A. Peters.

Medical and Surgical Devices

Renewable Dental Slab—In the form of a renewable surface which may be removed and discarded and a fresh surface exposed for the next mixing operation, thus saving time in cleaning the customary glass slab. Patent 1729292. John J. McCarthy.

Back Washer—Which embodies means for containing a detergent or soapy solution which will reach the back or other parts being washed, may also be readily converted into a medical appliance for a bandage, or poultice holder. Patent 1730299. Adam A. Sanders.

Prime Movers and Their Accessories

Rotary Engine—Having an intermittent coupling between the rotors and drive shaft which admits of the operation of the motor in either a clockwise or counter clockwise direction by employing ignition devices at two points. Patent 1732995. Traugott Tschudi.

Choke Control for Carburetors—Adapted to engage the usual actuating rod for the choke valve permitting ready actuation, but which will cause the rod to travel slowly after release as the valve is opened by the usual spring. Patent 1732969. Stuart G. Garrett.

Piston Ring—For internal combustion engines, having spring means retained in tubular members within the piston adapted to exert a steady outward pressure thereby fitting a wide range of cylinder diameters and automatically compensating for wear. Patent 1732978. Thomas O. McLendon and James H. Irving.

Pertaining to Recreation

Fishing Rod—Of the extensible type, comprising a hollow cylindrical handle and a tapered body portion capable of adjustment, and having means for firmly clamping the parts at any desired length, when retracted may be conveniently carried. Patent 1731173. William E. Pope.

Merry-Go-Round—So constructed that children can exert a push or pull to turn the revolvable portion of the structure, the arrangement being such that a number of children can stand on a platform and operate the device. Patent 1733005. Herbert D. Clayton.

Pertaining to Vehicles

Moisture Trap for Automobile Crank Cases—For trapping the accumulated waters of condensation which settle at the lowest point in the crank case, whereby the water may be drained off to prevent stoppage by freezing. Patent 1729978. Edward T. Barron.

Top for Automobile Rumble Seats—In the form of an attachment, characterized by its simplicity, ready adaptability, removability and collapsibility, to permit it to be stored in a relatively small space when not in use. Patent 1729919. Otto Altenbach.

Vehicle Bumper—Having a light reflecting element by which light rays from the headlights of an approaching vehicle will illuminate the bumper, thus enabling approaching vehicles to safely clear each other, notwithstanding glare from the headlights. Patent 1729274. Stephen P. Millar.

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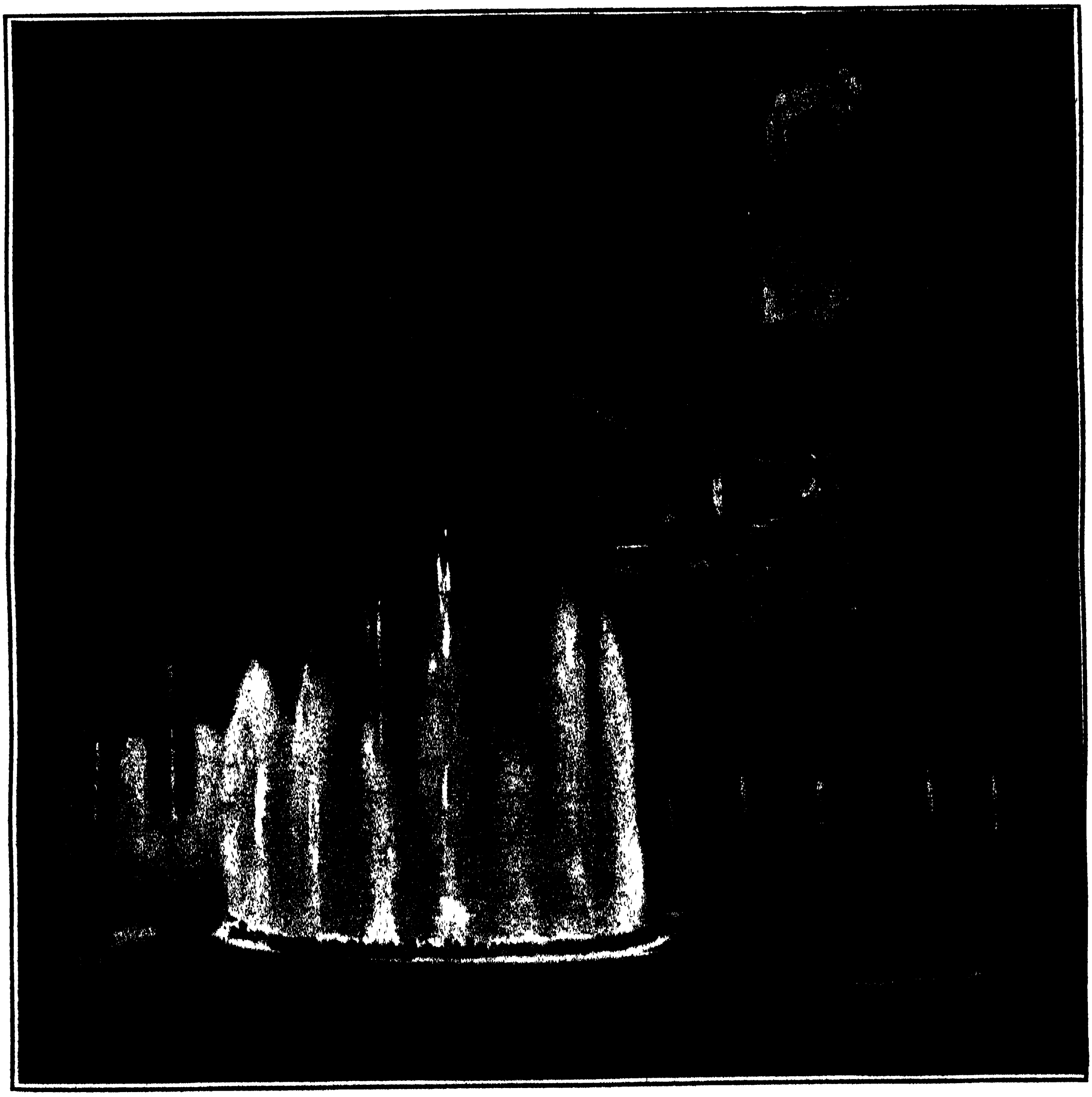

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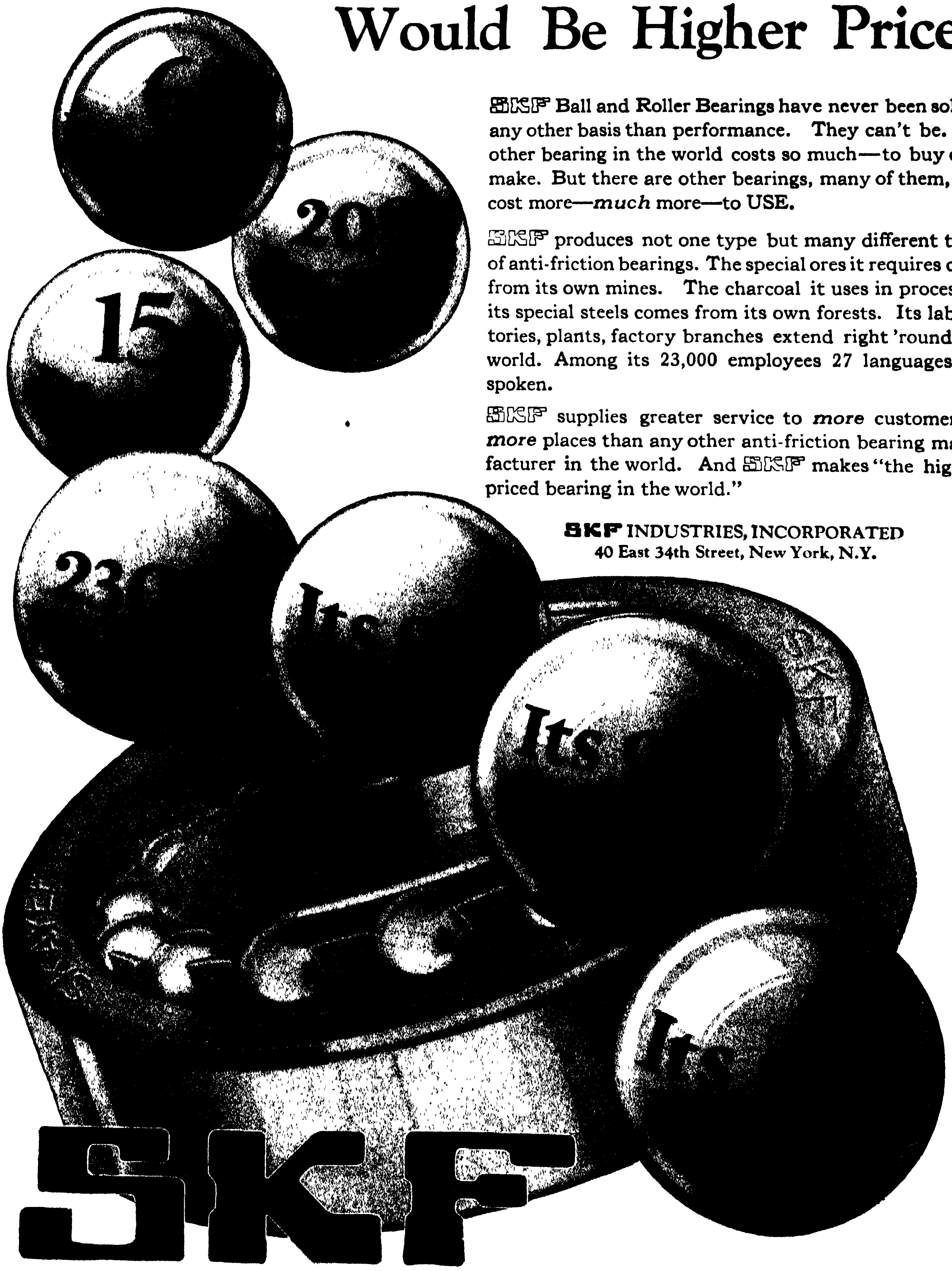

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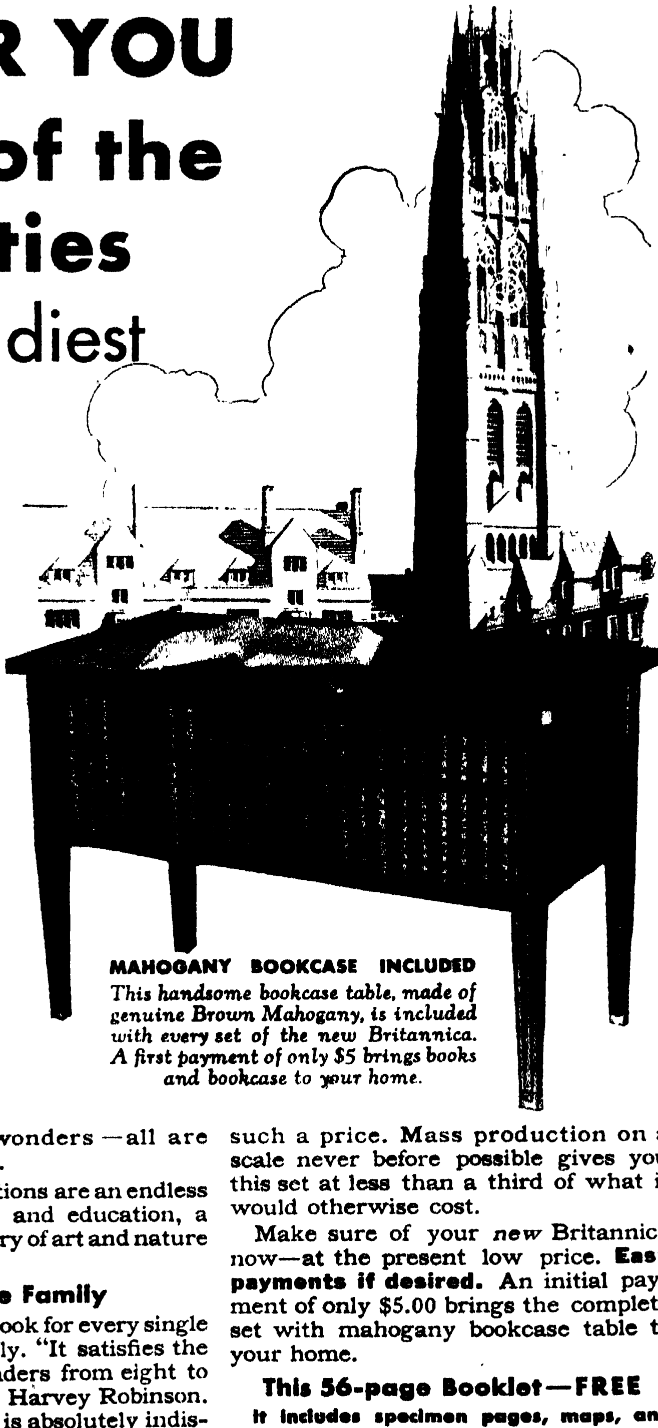

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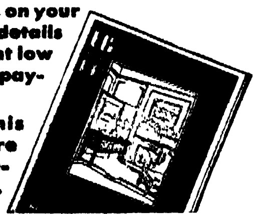

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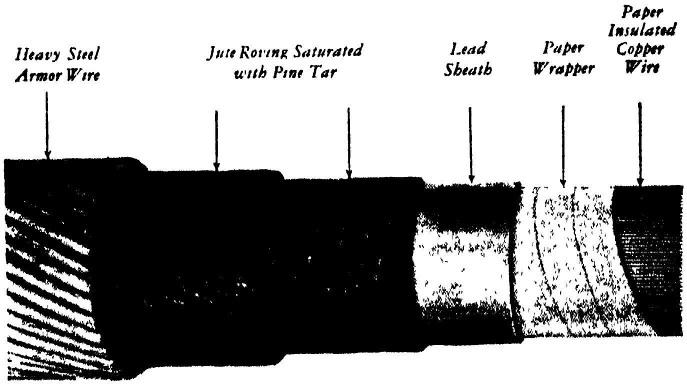
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COVER

"Painting with light," has become one of the most noteworthy features of the world's great exhibitions. Our cover, done in oils by Howard V. Brown, shows a night scene at the Barcelona International Exposition. Within the decorative area, illuminated by an ever-changing variety of colored fountains and cascades, all direct lighting has been dispensed with. When Chicago stages its second World's Fair, in 1933, even more spectacular lighting effects will be achieved, according to plans recently announced by the Committee on Illumination.

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Looking Ahead *With the* Editor

A Microcosmic Egg

"THAT there is such an object as an egg, wherein every human being has his origin, no longer astonishes the layman. Few people, however, realize the minuteness of this all-important microcosm which is pretty near the borders of unaided vision." It is larger, however, than that of the cow and of many other large animals. To learn more about this biological subject, look for our forthcoming engrossing article.

Down With Crime!

WE hear much about organized crime nowadays, but little of crime detection methods except in fantastic fiction. But society is gradually organizing to combat the criminal with science that will excel in results anything that Sherlock Holmes, Craig Kennedy, or Philo Vance ever did in fiction. Criminals will, therefore, eagerly read our coming article on one city's scientific police department so they'll know what to expect; and you will find it mighty interesting reading.

Suspended Gravitation

IF a bubble of air is released at the bottom of a bottle of water at the instant the bottle is allowed to drop, will the bubble rise in the water? Ten chances to one, your answer will be "yes." But the answer is "no," for it is a case of suspended gravitation. If you don't believe it, you can prove it yourself by an exceedingly simple experiment which will be completely explained and illustrated in a coming article by a famous scientist.

Swimming

SWIMMING is an old and yet a young sport. Scarcely any scientific study of it has ever been made so that when confronted with questions as to the efficiency or speed of modern strokes, we are at a loss for an answer. Now, however, a professor of physiology has, by means of a recently perfected natograph, found the answer to many questions pertaining to swimming and will describe his experiments in these pages soon.

A Newspaper in the Making

CHICAGO is pressed for building space. Thus the Chicago Daily News Building, a model structure in every way, was built over steam railroad tracks. Smoke from the trains beneath is evacuated by an ingenious ventilating system and a stack to the top of the building. This and many other notably up-to-date features characterize this building and the newspaper it houses, as described in an article to be published soon.

Every Issue Fully Illustrated

¶ Men are known by the magazines they read. What easier road to distinction could there be than reading the SCIENTIFIC AMERICAN—*at four dollars a year?*

Among Our Contributors

Alfred C. Lane

PROFESSOR Lane's eminent career as a geologist has helped to fit him for the latest work for which he has been selected by the leaders of science—the determination of the earth's antiquity by means of the radioactivity of rocks. Educated at Harvard and at Heidelberg, he served during several years as State Geologist of Michigan. Later he was professor of geology at Tufts College. To be exact, his profession is petrology.

Martin Meyer

DR. MEYER is a professor of chemistry and a consulting chemist. Although his researches, as listed in "American Men of Science" are with organic sulfur compounds, lead tetraethyl, dehydrothiotoluidin, perfumes, et cetera, he is said to derive the greatest satisfaction from the popularization of science. In addition to his article in this issue, we will publish soon another interesting and informative article from his pen.

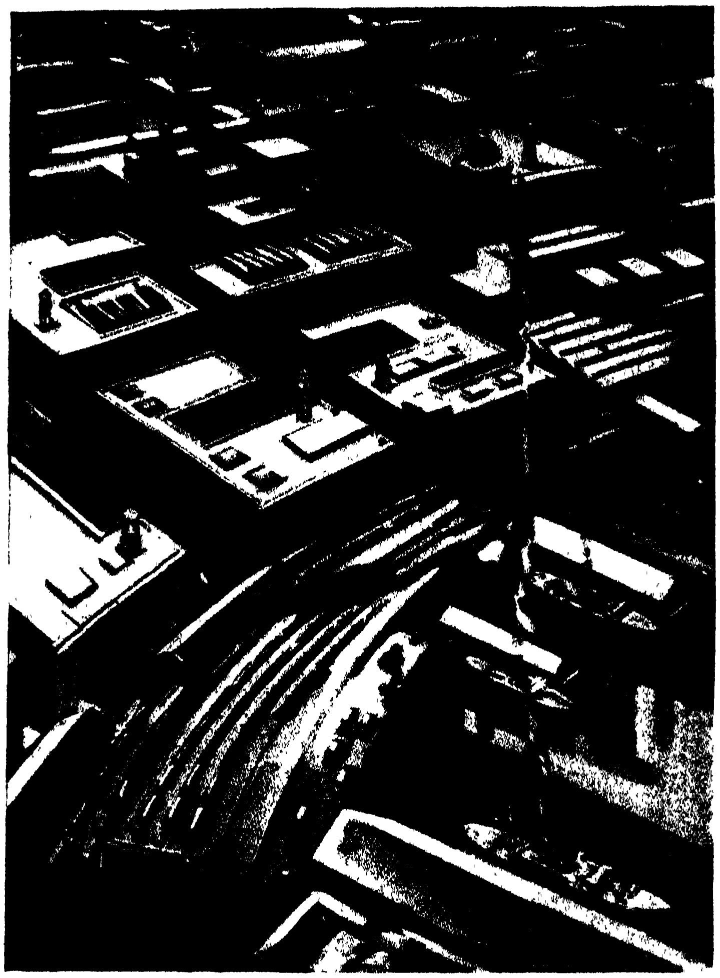
Calvin P. Stone

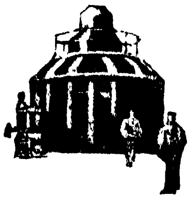
DR. STONE, Stanford psychologist who writes of rats in this issue, finds them an interesting subject for observation and study. He was for a time Director of Research of the Psychological Laboratory in the Indiana State Reformatory. During the World War he was psychological examiner in the United States Army. Animals have supplied him with much material, his specialty being animal psychology and behavior.

F. M. Jaeger

CONSIDERED an international authority in his chosen field, Dr. Jaeger is now professor of physical and inorganic chemistry at the University of Gronigen, Holland. His researches have taken him into abstruse physics and chemistry and he has, successively, been a physicist, mineralogist, chemist, and crystallographer, and has published much on all these subjects. His book "Inleitung tot de Studie der Kristalkunde" is the only one of its kind devoted to a comprehensive study of symmetry in all its aspects and is authoritative. During part of the 1928-29 term, he was George Fisher Baker non-resident lecturer at Cornell.

POWER in Los Angeles where 40% of Pacific Coast Population is Centered...





Density of population rather than geographical location determines sales activity of a market. This, with abundant low cost water and power, creates the most ideal conditions for development of profitable industry in Los Angeles. Write for specific information on water and power costs for your industry. Address Business Agent, 207 South Broadway, Los Angeles, Calif.

11th Manufacturing City

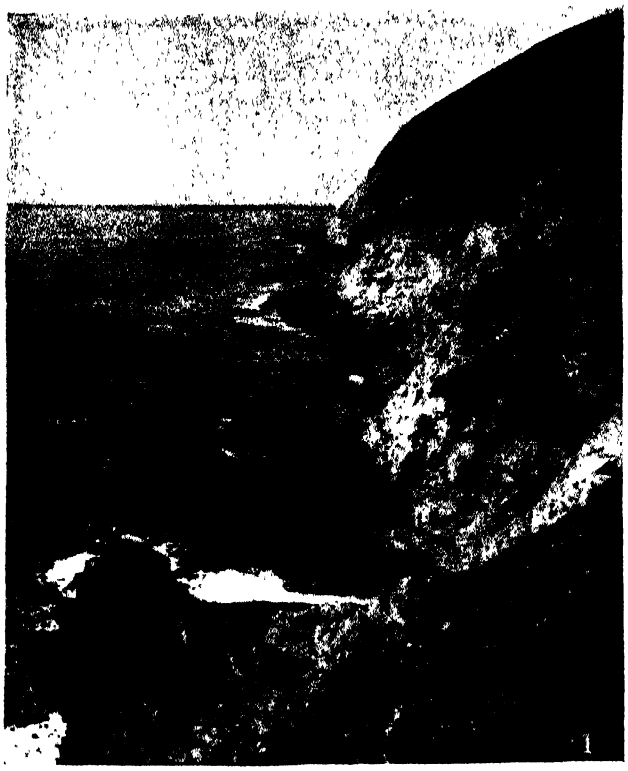
A MANUFACTURING city representing over 2,000 industrial connections was added to the power lines of the Bureau of Power and Light in the last 5 years! A population equivalent to Rochester, N. Y. settled in this city during the last 10 years. Two Powers... *electric and buying*... give Los Angeles 11th place among industrial cities of the nation.

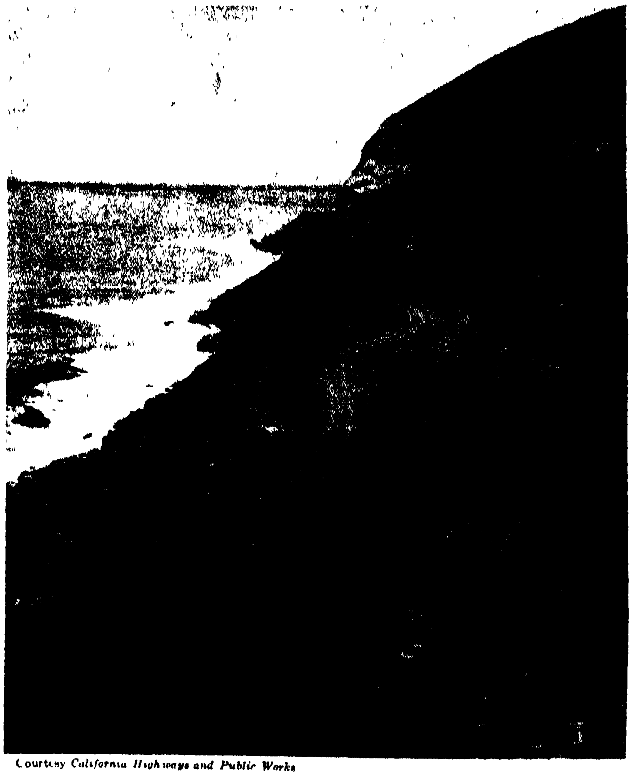
CITY-OWNED
BUREAU *of* POWER *and* LIGHT
CITY OF LOS ANGELES

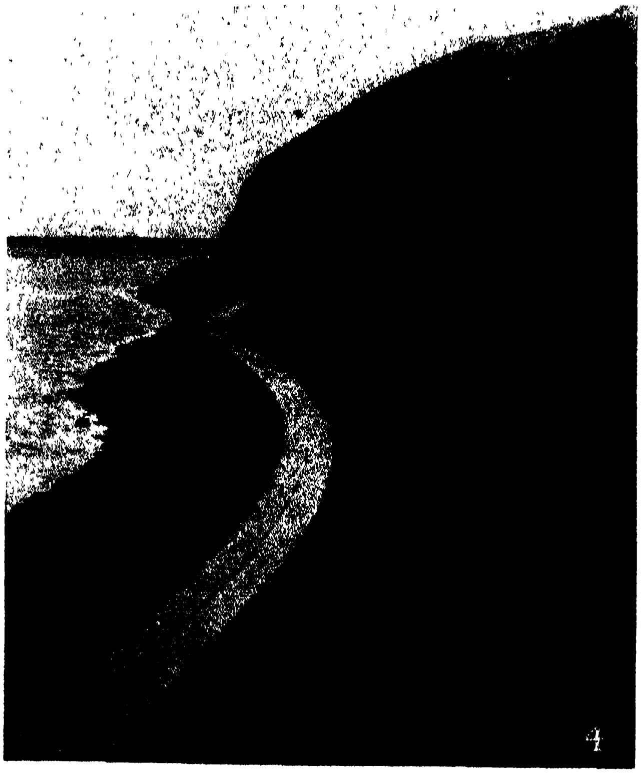
INDUSTRIAL LOS ANGELES

Private James P. Rigby

THE winner of our light-plane contest, Private James P. Rigby of the 65th Service Squadron, located at Luke Field, Honolulu, T. H., was born June 22, 1909, in Media, Pennsylvania, and spent his early childhood in New Jersey. After finishing high school, he enlisted for the Hawaiian Department of the Air Corps in February, 1928. His first ten months were spent in a Bombardment Squadron, but desiring to be in the Engineering Offices he obtained a transfer to his present squadron where he finds ample time to browse through technical literature and study as well as read the SCIENTIFIC AMERICAN, *Aviation*, and *Flight*. When his current enlistment terminates he hopes to find employment with an airplane company. He pays a charming tribute to his widowed mother who made his career possible by giving him a good education.







Courtesy *California Highways and Public Works*

Growth of the Highway

ON this particular section of the Santa Monica-Oxnard, California, highway, which was formally opened to traffic in 1929, many difficulties were encountered and overcome. A glance at illustration Number 1 will show why it was necessary for surveyors and workmen to be suspended from above like Alpinists, prior to the beginning of work and during the early stages of construction. Since there were no shipping points between Santa Monica and Oxnard, a long expensive haul was required. Water for construction purposes had to be obtained from a city over 12 miles away, through a specially built pipe line. Seawalls could not be built to keep back the waves; therefore huge rectangular blocks of concrete were lowered into the ocean and then filled with concrete. Illustrations 2 and 3 show construction stages, and Number 4, the completed highway. Construction of the seven most difficult miles at this point cost 1,000,000 dollars.

Courtesy United States Lines

THE "LEVIATHAN," AMERICA'S FINEST, PASSES THE STATUE OF LIBERTY, INWARD BOUND

American Ships and American Prosperity*

A Discussion of the Weak Link in Our Transportation System and the Need of Public Support for a Greater Merchant Marine

By E. M. HERR
Vice-chairman of the Board, Westinghouse Electric and Manufacturing Company

THERE was a time, not so many decades ago, when American clipper ships carried a large proportion of the world's commerce. Then came a decline which lasted until after the World War. Now our foreign commerce leads the world and we need more ships for the same reason that one department store does not employ another store's trucks to deliver its goods.

New ocean mail routes will greatly stimulate shipbuilding, for the construction of 29 ships, two of them super-liners, is to be specified in the contracts. But this will be only a start.

Mr. Herr's accompanying article puts us to shame for our apathy in respect to our merchant marine. It is hoped, therefore, that his discussion will aid in renewing that old feeling of pride Americans possessed when our flag floated above some of the finest and fleetest ships in the world. —*The Editor.*

AS A DIRECT result of the sound economic policies which have been pursued by both American industry and the American government, the people of the United States have enjoyed unprecedented prosperity during the past few years.

The extensive use of power in industry, the development of the system of mass production for a large number of manufactured articles, and the rapid practical application of the discoveries of science and research, have greatly increased our national productivity and our national wealth. This added wealth, contrary to what has often happened in the past, has not been largely absorbed by a small group, but practically all who have had a hand in its creation have shared in it, so that wages have risen, the purchasing power of the majority of our people has widely extended, and the standard of living in this country has reached the highest level ever known. Finally, there is every reason to believe that those disastrous financial crises, which have periodically wiped out a large proportion of the savings accumulated in prosperous times, have been eliminated by the Federal Reserve Banking System.

Never before, in fact, has so much been accomplished for the good of so many people in such a short time.

But, although the American peoples as a nation are prosperous and content, there is a minority who are actually being injured by the very processes that are benefiting their fellows. Although society as a whole gains whenever a new type of labor-saving machine is placed in operation, or research discovers a better way of performing some operation, certain individuals invariably suffer loss by being thrown out of work. Experience shows that unemployment due to this cause is

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*Reprinted by permission, from a monograph

Courtesy Grace Lines

LAUNCHING THE "SANTA CLARA"

usually temporary, since the wealth created by the new improvement always creates a demand for labor elsewhere; but this does not ameliorate the immediate distress of the unemployed, and on more than one occasion during the past five years, our industrial progress has taken place so rapidly that thousands of families were in want for long periods of time.

To this group, which our general prosperity has failed to touch, must also be added the American farmer. Whereas the agricultural industry has made progress during the past 50 years and the average farmer of today is much better off than was his grandfather, the status of the industrial worker has improved so much more during this same period that the farmer's economic position is relatively lower than it was formerly. Hence there is justification for the discontent that pervades many of our rural districts.

IT is typical of the spirit that now dominates American affairs that these weak spots in our otherwise highly satisfactory state should command widespread attention. We can confidentially believe that, insofar as it can, our national government will work out practical plans for farm relief, arrange work on public undertakings so as to reduce unemployment in times of depression, and carry out other constructive measures. But while vast good can thus be accomplished, it must be recognized that government is a remover of obstacles rather than a creator of economic opportunities, and that only economic remedies can permanently cure economic ills—and then but slowly.

What we chiefly need is an ever widening market for our goods. If we could constantly increase the demand for both our manufactured and our agricultural products by even a few percent per annum, much of the slack in our production system would be taken up, unemployment would be kept down to a minimum, and a much needed stimulus would be given to agriculture. In other words, one of the most effective things that we can do at this time to widen the scope of our prosperity is to build up our foreign trade.

We have never, as a people, been "foreign-trade minded," like the British, for example. Although the value of our foreign commerce in 1927 was in the neighborhood of nine billion dollars, it represented only about 10 percent of our total business, and this small proportion has been maintained very closely for many years. We have in this field almost unlimited opportunities for commercial expansion but as a nation we have not taken advantage of them. The time has now arrived, however, when we must embrace all opportunities to increase our overseas markets.

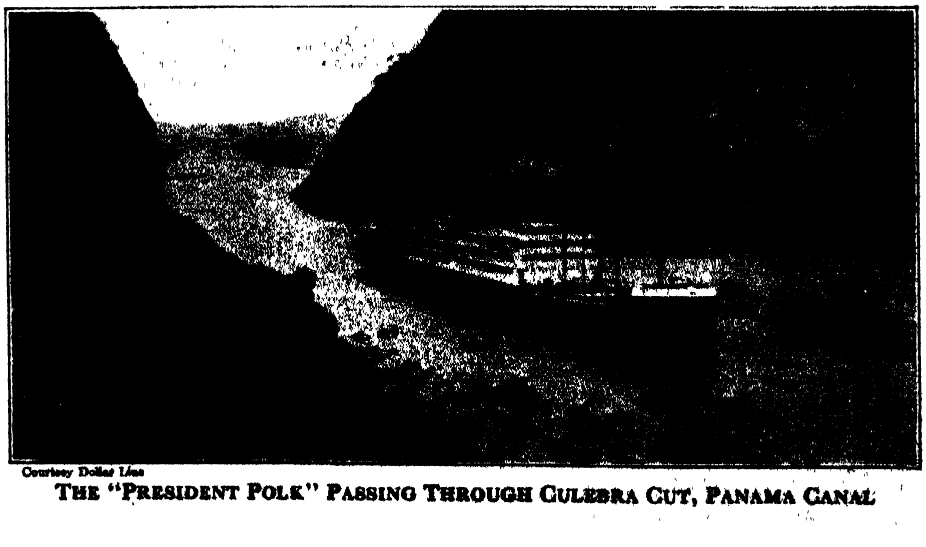
MUCH of the task of extending our foreign trade will, of course, devolve upon commercial, industrial, financial, and political specialists, but there is one phase of it which is the concern of the American people as a whole. If we want to maintain and extend our prosperity by developing foreign trade, we must strengthen a serious weakness that now exists in our transportation system.

Transportation and production are inseparable. If there is a free flow of goods from the producers to the consumers, the greater the quantity of useful articles the producers can turn out, the better off everyone concerned will be. But interfere with this flow anywhere and everyone will suffer loss; stop it, and civilization will disintegrate.

Fortunately for us, our transportation system as a whole is splendidly developed. Our railroad system is larger and more efficient than any other in the world. We own 78 percent of all the automobiles in existence and spend billions of dollars every year for new cars and trucks and for road improvement. Our aviation system is at present in its infancy, but, in view of the present public interest in this subject, no one can doubt that we shall in time be supreme in this field also.

EVEN in what might be called the minor branches of transportation, our position is satisfactory. We have an adequate fleet of lake-going, coastwise, river, and harbor craft, which is being increased as needed by vessels of the most modern types; we have added nearly 100,000 buses to our already extensive urban and interurban railway system; and although electric traction has had to mark time for several years because of the extremely rapid development of the automobile, it is now entering into a new era of active progress and promises to be one of the most important factors in solving the serious problems created by traffic congestion in our cities.

In striking contrast to all this is our international transportation system. While on paper our sea-going merchant fleet totals 11,000,000 tons and is second only to Great Britain's, 50 percent is probably useless and perhaps 50 percent of the remainder is obsolete or nearly so. As to new ships, without which the efficiency of our fleet cannot be maintained, only 3 percent of the ocean-going ships built since 1923 belong to us; and during 1928 we did not spend a single cent on ships for foreign trade. The percentage of our imports and exports carried in our own ships

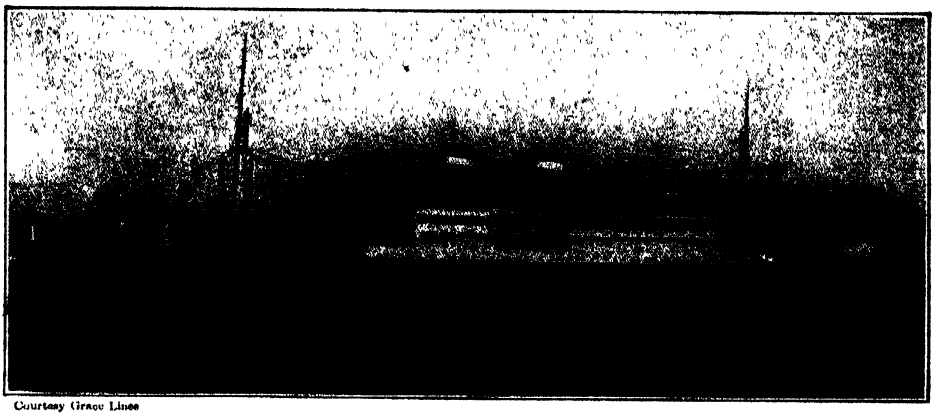


Courtesy Dollar Line

THE "PRESIDENT POLK" PASSING THROUGH CULEBRA CUT, PANAMA CANAL

has been slowly but surely declining since the high point of 1920, so that we are obviously in danger of slipping back into our old-time position of almost complete dependence on foreign ships for handling our sea-borne commerce.

We should, indeed, be ungracious if we were to criticize the shipping service that foreign nations have rendered us in normal times; nevertheless, blood is thicker than water, and a ship is always bound to its mother country by strong political and economic ties. On more than one occasion we have been left in the lurch, with our products, many of them perishable, piled upon our wharves because ships of foreign register, on which we were depending for transport, were suddenly drawn elsewhere for some reason that was no concern of ours.



Courtesy Grace Lines

MOTORLINER "SANTA MARIA," ONE OF A LARGE AMERICAN-OWNED FLEET

A CLOSELY parallel situation would exist in our domestic transportation system if the great majority of our freight locomotives and trucks were under foreign ownership and control and were liable at any time to be withdrawn from our service and sent to Canada or Mexico. Obviously, under such circumstances, it would be impossible to develop that fine adjustment that now exists between our production and our transportation; and our internal commerce would be but a fraction of what it is at present. And yet, if we were thoroughly accustomed to this method of handling our traffic, we would perhaps find it difficult to realize what we were losing by not taking it under our own control. We would undoubtedly, from time to time, consider the question of substituting our own rolling stock for that supplied by foreign capital, but the cost of the operation would stagger the average man, and, because of the numerous invisible factors involved, he would probably be quite unable to understand how so great an investment would benefit him personally.

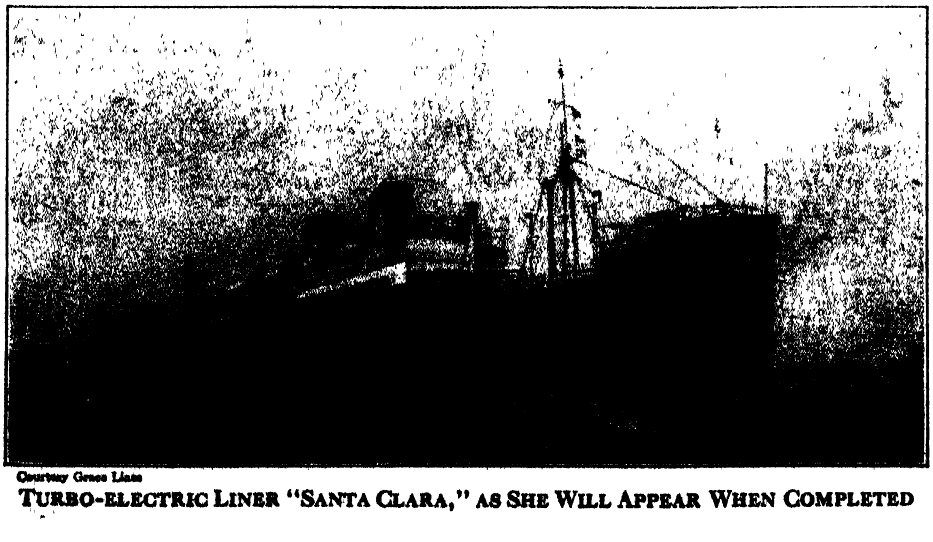
For similar reasons, the American people have been slow to appreciate the value of a merchant marine of their own. As long as less than 10 percent of our business is seaborne, it does not matter very much who handles it; but if we wish to develop a large volume of foreign trade, we must have an adequate number of the right kind of ships under our own immediate control and serving primarily our own national interests, for without them we shall not be able to insure that reliability of transportation service which is essential for the success of such an undertaking.

Another highly beneficial result of the building up of an American merchant marine would be the revitalizing of shipbuilding in this country. Prior to the war, there were 23 shipyards in the United States building sea-going vessels; today there are but 12, and several of these are barely maintaining their existence on the odds and ends of repair work. Great Britain, on the other hand, has 57 yards, and Germany has 18.

If an adequate amount of business could be given to our shipyards, a goodly share of our surplus labor would be immediately absorbed; a demand would be created for large amounts of steel, machinery, and other of the innumerable supplies needed for ships; the producers of these materials would give employment to other workers; and thus an ever-widening circle of prosperity would be started. Moreover, we would save from extinction an industry that is absolutely vital to our national safety. We cannot afford to let our shipbuilding machinery decay and our technically trained shipbuilding staffs disintegrate. If we become unable to build ships to meet our needs in emergencies, we shall lose our grip on sea power, and then our seaboard, our island possessions, our commerce, and our prosperity would be at the mercy of any maritime nation that chose to attack us.

The situation is more promising today than it has been for a long time. Within the past year, Congress has passed certain legislation in the interest of our shipping and shipbuilding, and there is every reason to believe that work on a number of new sea-going vessels to fly our flag will be started in the near future. But without that widespread popular interest and support which created our railroad and our automotive transportation systems and which at present is playing so important a part in developing American commercial aviation, we shall have no merchant marine.

THIS whole subject is a matter that concerns all of our people—merchants, manufacturers, public utility operators, professional men, farmers, and workers—for even a moderate increase in our overseas commerce and our shipbuilding activities will result in a marked increase in the demand for labor, materials of every description, power, internal transportation, and all other varieties of service, and this will benefit everybody. Our industrial and political leaders can, in fact, do few things more useful than to create public understanding of the value, to every American individually, of foreign commerce and an adequate merchant marine.



Courtesy Grace Lines

TURBO-ELECTRIC LINER "SANTA CLARA," AS SHE WILL APPEAR WHEN COMPLETED

¶ *In constructing the new vehicular tunnel under the Detroit River from Detroit to Windsor, Canada, new engineering methods were used and problems were overcome. The interesting story of this work will be published in these pages at an early date.*

OUR POINT OF VIEW

California Sees the Light

QUALIFIED scientists, engineers, architects, builders, and real estate men of California have for many months been laboring over a uniform building code due to appear in the coming spring. This code will take frank and, it is stated, full recognition of existing earthquake risks in that state as determined—or as nearly as existing knowledge permits determination—by the science of seismology.

Such a code is past due. The lesson of the San Francisco earthquake has been wearing off. San Francisco itself not long ago reduced its own specifications for earthquake resistance in its building code.

As Henry D. Dewell, a consulting engineer, reports to the Seismological Society of America, an earthquake catastrophe first arouses a lethargic public, building regulations are made more stringent, codes are revised to match the advice of technical advisers; and then the cycle of events pursues its course: people become forgetful, familiarity with what science alone seems to realize is only a temporary let-up in earthquakes begets contempt, and building codes are allowed to lapse. Then comes another disastrous earthquake.

The time of *least* danger of earthquakes is directly after an earthquake—just when building codes are stiffened.

The time of *greatest* danger comes years later when earth stresses, temporarily relieved by the earthquake, have again accumulated—just when building codes are being weakened.

There must be some way to bridge this characteristic blind spot in human nature and provide stronger buildings at the proper time instead of at the wrong time. This is what science and engineering are now doing in California. It is, of course, only common sense, but common sense is a quality not too often noted in connection with public matters of this kind. Therefore the action deserves praise from all scientific people.

The Naval Conference

THE recent rebuff our Secretary of State, Mr. Stimson, received from the Soviet Government indicates the great difficulty one state has in understanding the reaction its policy will meet abroad; certainly Mr. Stimson's action was inspired by innocent motives but it raised Russia's resentment and encountered the thinly veiled hostility of Japan. The three directly interested parties were Russia, China, and Japan; China appealed to the powers when she became unable to sustain her position by force; Russia believing her cause was just and knowing her soldiers could maintain her position refused to leave the decision to outsiders; Japan disliked the idea of a concert of powers interfering in Manchuria lest a precedent be established that could be used in some future Manchurian problem in which she might be involved.

Television and the Cathode Ray

ALTHOUGH television, seeing at a distance, is a subject that incites the mind to fanciful flights into the future, the practical development of the art has been exceedingly slow and, so far, unproductive of satisfactory results. In 1889, Paul Nipkow, a German experimenter, devised an "electric telescope" and in his patent application he laid the foundation for all future disk-type television transmitters and receivers. Since that time progress has consisted almost solely of refinements and developments based upon Nipkow's original apparatus. Now, however, comes the hope that in the near future cumbersome scanning disks and drums, capricious neon tubes, and difficult-to-synchronize motors may be eliminated from the television reception field and replaced by the comparatively simple cathode-ray tube in which no moving parts are employed. A description of the cathode-ray television system appears in the SCIENTIFIC AMERICAN Digest of this issue, and it is our sincere hope that other experimenters will take up the work of Dr. Zworykin and thus bring successful practical television nearer to the average person's home.

In much the same manner, France and Italy have become fearful of a possible Anglo-American agreement relative to cruiser strength, and their attitude may cause the failure of the London conference. In addition, France has a real naval tradition and is reluctant to accept a naval position inferior to Japan; France regards the control of the water route to Algeria as vital to the effective strength of her army which contains a large African contingent; and while France will support Italy against a supposed Anglo-American combination, she will bitterly oppose an equality with Italy for with colonial possessions only exceeded by Britain, she considers her needs are much greater than Italy's. Finally, France must retain her submarine strength as a counterpoise to Britain's superior surface fleet.

So the complexities of the situation the London conference will face are becoming more and more evident; on the other hand President Hoover and Premier MacDonald have skillfully avoided many pitfalls in handling the preliminary measures; they are supported by an overwhelming public opinion in favor of reducing armaments and it only remains for conciliatory statesmanship to find the solution.

The country approves the President's action in surrounding our civilian members of the conference with experienced naval advisers, and the previous records of Rear Admirals Jones, Pratt, Moffett, Pringle, Yarnell, and Hepburn insure that the civilian members will be furnished the necessary technical assistance. Our President is too sagacious to ignore the necessity of expert advice. We feel sure that the presence of these Flag Officers in London assures the safeguarding of American interests, and we fondly hope the collective wisdom of the assembled delegates will find a solution that will further world peace.

Now is the time to limit armaments, for much of the hatred of the World War has evaporated while the memory of the suffering it caused is still fresh. No thoughtful person believes that eternal peace can be established in the present era; but some causes of war can be removed entirely, others may be neutralized, and war perhaps deferred until civilization is better able again to withstand the shock of arms. If the conference only succeeded in postponing one small war for a decade, it would deserve well of the world, and any success it may have will encourage succeeding generations to carry on the task of seeking peaceful solutions of world problems.

Our Permanent Prosperity

MOB psychology is a peculiar thing. When stocks first began to drop in the recent stock crash, many thousands of people frenziedly unloaded, like so many sheep following the leader, and almost caused an industrial collapse from which it would have taken months to recover. The stampede forced stocks to a very low point despite the fact that business was basically sound.

President Hoover understands mob psychology and so took immediate steps to circumvent its destructive influence. He knew that if the man in the street could not see figures in black and white, this man would cry "hard times" and would curtail his expenditures; the cry would be taken up by others; and the mob's pessimistic belief would become actuality. Mr. Hoover therefore called upon all state governors for facts as to their states' projected work for 1930. The responses were most favorable; it was found that state construction on highways and public works for this year will run into hundreds of millions of dollars.

As early after the stampede as the first week in December, C. W. Nash, of the Nash Motor Car Company, stated that his company had found no cause for worry; their sales had been maintained on a par with, and in some cases showed an increase over, preceding years. Henry Ford, shortly after having reduced prices on all models of Ford cars, announced a general increase in the wages of all employees. Recently the United States Shipping Board certified a program of ship construction for our merchant marine which calls for the building of 29 vessels based upon ocean mail subsidies. Several of these will be begun almost immediately, thus assuring much business for our shipyards, employment of many men, and the use of much steel— and steel production is referred to as "the barometer of business conditions!" The *Engineering News-Record* recently published a survey showing that the cost of construction for 1930 will total around ten billion dollars.

Many other facts and figures could be quoted to show that 1930 will be a busy and prosperous year—we could cite the increase in bank deposits recently, and in stamp sales, the latter also called a business barometer—but the case is already proved. Yet the same old mob psychology, still pessimistic in tone, tends to hang on. There is thus the necessity for constructive optimism on all sides, plenty of hard work, and the free circulation of money so that business and industry may boom and a stabilized prosperity be ours permanently.

To such criticisms of our financial structure as that voiced, with puerile acerbity, by the Soviet press relative to the market crash: "So this is what can happen in a capitalistic country!" let us point to our 1930 program and say, "*This* is what *will* happen." Then let us forget criticisms and critics along with pessimism and other unpleasant things.

Swan Song

IN January, 1927, we published an editorial which stated that the average annual increase in the number of installations of electric household refrigerators from 1920 to 1925 was 100 percent, that the year's increase in 1925 alone was 350 percent, and ventured a prediction as follows:

"Imaginary conversation in 1977—*Grandpa*: 'When I was a young man, they actually brought ice into peoples' houses to keep their food cool.'

"Laughter.

" 'Grandpa, wasn't that in the days of the candle?' "

An Industrial Antarctic?

TO those of us who studied geography long before the World War, the problem of relearning the map of Europe after its remolding was indeed a difficult one. It is possible, or rather probable, that in a few years it will be necessary—if, of course, we wish to keep up with the times—for us to familiarize ourselves with the map of an entirely new continent: the Antarctic.

Already with several notable and well-known achievements to his credit, Commander Richard E. Byrd is now exploring by air and mapping in photographic detail this last great unknown and puzzling part of the world. In the SCIENTIFIC AMERICAN Digest of this issue we publish a map of his recent flight to the South Pole and give an idea of some of the facts that may be learned by him in the Antarctic. Besides the valuable data mentioned in that item, however, perhaps he will bring back other information that may lead to commercial exploitation of natural resources which some have predicted may be discovered there.

Who knows but that in the years to come there will be numbers of year 'round base camps, similar to Byrd's Little America, scattered over the Antarctic and peopled by hundreds or thousands of workmen who extract from the mountains there such natural wealth as gold, diamonds, oil, coal, or iron? Airplanes or airships might transport the more valuable of these from the interior to shipping points and methods might be found to ship the more bulky. The question, of course, is: Does the Antarctic contain any minerals of value or is it simply a barren, rocky land? Byrd will doubtless give us some information on that point and others will help our enlightenment. We may yet see the Antarctic a thriving industrial continent.

We thus gave a conservatively long time for the supplanting of the old ice refrigerator by the modern electric one. Since 1927, however, increasing use of the latter has been so marked as to indicate that the imaginary conversation may be possible in much less time than the predicted 50 years. And yet there are die-hards who either are myopic and thus cannot see the handwriting on the wall or are so deeply concerned financially that they are fighting the change with the frenzy of despair. We have no sympathy with the former because they are of the type that drag the wheels of progress but for the latter our feeling is somewhat similar to that we had for the buggy makers when the automobile made its appearance. We are simply sorry that, in time, they will have to turn to other things.

In this latter class we would place a certain association of ice manufacturers which, after we had published the article "Ice By Wire" in our October, 1929, issue, informed us that the article was fundamentally, essentially, and technically wrong, and demanded that we retract. Unfortunately for them they posited a weakness on our part which we do not possess. The article was not hastily prepared; on the other hand, it was presented only after careful consideration and study of the situation and then under the guidance of refrigeration experts. What, then, is there to retract? Nothing.

We can pass over this association's criticism that our title "Ice By Wire" was incorrect for obviously it was not to be taken literally. Likewise, we cannot retract our statement that, as a refrigerant, sulfur dioxide has very little danger either as a poison to human beings or as a corrosive agent for the pipes or interior of the refrigerator. It is admitted that the electric refrigerator is not actually electric but the term "electric" is as descriptive here as when used with such appliances as electric vacuum cleaners, electric dish washers, et cetera. We reiterate that there is less spoilage of food in electric refrigerators due to the lower temperature and to the lack of moisture.

We were of the opinion that ice manufacturers, faced by the competition of the electric refrigerator, have expanded into new fields and actively promoted their business. For that reason, we were rather surprised at the association's statements that "From the standpoint of economy, efficiency, and service, the ice industry has nothing to fear from mechanical refrigeration competition," and that "—the small ice machine"—with which name they choose to heap indignity upon the apparatus under discussion—"would not have reached its present degree of use had it not been backed by the enormous financial power of——; coupled with the fact that dangers and disadvantages of small ice machines have been studiously hidden from the public." And yet they did not enumerate these vital facts that have been *studiously hidden from the public.*

The association's argument reminds us of the little boy on a gloomy road at night, whistling to cover his fear, and of Hamlet's rebuke to one who thus practiced dissimulation: "The lady protests too much, methinks."

How Old Is the Earth?

How Geologists, Physicists, Geophysicists, and Other Scientists Are Pooling Their Knowledge for a Combined Attack on This Ever-fascinating Problem

By ALFRED C. LANE, Ph.D., Sc.D.
Chairman of the Committee of the Division of Geology and Geography on Estimation of Geologic Time by Atomic Disintegration, National Research Council

LOOK with a pocket lens at the luminous numbers of the dial of a wrist watch after you have been sitting two or three minutes in the dark. The figures do not shine with a quiet, steady glow but quiver with light. If the lens defines sharply you will find that the light comes from showers of sparks, like bursting rockets; or, it may be, more like that of fireflies on an August night. Each flash is made by an exploding atom.

We know now that the atoms of the chemical elements are not the "indivisible" units they were thought to be when that name was given to them, but according to one conception they are complex aggregates of positive protons and negative electrons. The outside electrons of an atom are pictured as whirling around the central nucleus with a velocity so great that they may be thought of as being practically "all over their orbit" at once. In the heavier atoms the number of outside electrons becomes very large, up to 92, and for some of the atoms the arrangements are too complex to be stable, so that once in a while they explode. Sometimes the explosion merely gives off an electron — sometimes it gives off what amounts to an atom of the light gas helium.

WHEN an atom explodes, the particle goes off with tremendous energy. We can imagine how great the energy is, from the fact that the particles have been going around their orbits many millions of times each second. When such a particle is set loose, like a stone from a sling, and strikes the white powder of an impure zinc sulfide, it causes a flash. Thus each of the flashes seen in the luminous paint on the watch dial represents such a collision.

Now if we were watching a pop-corn machine and counted how many kernels popped in a minute we could tell, provided the rate of popping was uniform, how long the machine had been running. Even so, with our popping atoms the physicist generally tells us that, so far as he can find out, the number of atoms of a spontaneously disintegrating element that explode per second depends only on the number that are present; and that this number is uniform, regardless of temperature and pressure, and regardless of other substances present. The experiments upon which this statement is based have ranged throughout the whole variety of conditions that might be present near the surface of the earth.

There are a number of these popping elements. Radium is the one in which this property was first recognized. While the rate of disintegration of radium is relatively rapid, incidentally causing it always to be warmer than its surroundings, the radium is half gone—its atoms half exploded—after some 1580 years. This is not, however, so fast that, like some of the other elements, radium vanishes under the chemist's fingers.

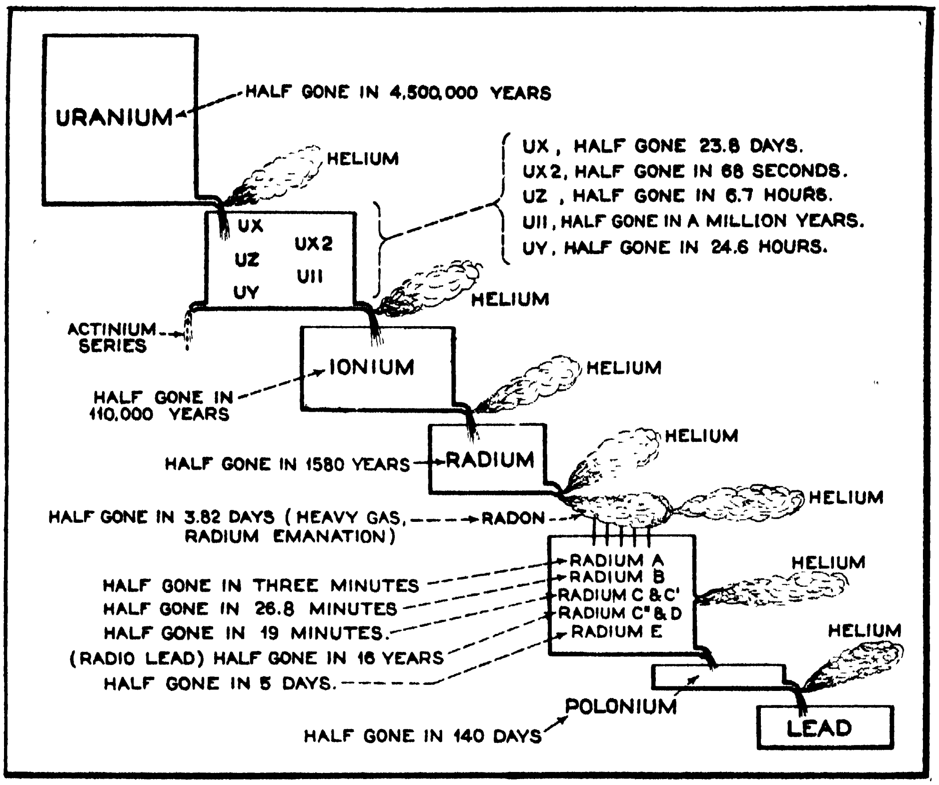
ANGEL TERRACE, YELLOWSTONE

By measurement of rate of decay of radium in these deposits it was possible to date the time since the recession of glaciers

By measuring the rate of decay of the radium contained in certain deposits, Schlundt of Missouri and Moore of Purdue estimated the time since the ice extended down to the geysers of the Yellowstone Park during the Great Ice Age. It was done in this manner: The water of the geysers contains radium, and the deposits of tufa laid down by the geysers are also radioactive. The older these radio deposits are, the less active they become. The older deposits of Terrace Mountain have a radioactivity of only 1 percent of the more recent ones and are overlain by boulder clay deposits of the glaciers. If, then, we assume that the original activity took place at the same rate as now, we can estimate the age of these deposits by the degree to which they have lost their original radioactivity. If radium loses half its volume during the first 1580 years, and half its remaining volume during the next equal period, and so on, it will be reduced to 1 percent of its original radioactivity in about 10,500 years.

However, the most suitable element for computing the great lapses of time since the earth's crust began to be practically at its present temperature and pressure is not radium but uranium. Incidentally, there is a very small amount of closely similar elements called "isotopes," that are grouped together under the name of uranium and distinguished as U I, U II, U X, U Y, and U Z, and so on. Ordinary uranium is mainly U I.

URANIUM is the source of radium, but its atoms are so much less explosive than those of radium that it would take 4,500,000,000 years for it to be half gone. In a milligram of uranium, which is about the quantity that would cover a circle as big as the letter *O* with a layer as thin as a piece of paper, there will be about 2,540,000,000,000,000,000 atoms. From this quantity of uranium we might see something like 11 flashes per second. From a mineral containing only ½ of 1 percent of uranium I have counted flashes at the rate of four a minute. As there are 31,556,926 seconds in a year, it is easy to see that if 11 atoms disintegrated per second per milligram, the uranium would be gone in 8,000,000,000 years. However, since the number of atoms which burst depends upon the total number present, the rate constantly diminishes. But


URANIUM
HALF GONE IN 4,500,000 YEARS
HELIUM
UX
UZ
UY
UX2
UII
UX, HALF GONE 23.8 DAYS.
UX2, HALF GONE IN 68 SECONDS.
UZ, HALF GONE IN 6.7 HOURS.
UII, HALF GONE IN A MILLION YEARS.
UY, HALF GONE IN 24.6 HOURS.
HELIUM
ACTINIUM SERIES
IONIUM
HALF GONE IN 110,000 YEARS
HELIUM
RADIUM
HALF GONE IN 1580 YEARS
HELIUM
HELIUM
HALF GONE IN 3.82 DAYS (HEAVY GAS, RADIUM EMANATION)
RADON
RADIUM A
RADIUM B
RADIUM C & C'
RADIUM C" & D
RADIUM E
HALF GONE IN THREE MINUTES
HALF GONE IN 26.8 MINUTES
HALF GONE IN 19 MINUTES.
(RADIO LEAD) HALF GONE IN 16 YEARS
HALF GONE IN 5 DAYS.
HELIUM
HELIUM
POLONIUM
HALF GONE IN 140 DAYS
LEAD

ATOMIC DISINTEGRATION SERIES SIMPLY ILLUSTRATED

In this diagram the atomic disintegration series is illustrated by water running down through a series of tanks. It shows what happens while radium is being transmuted into lead in nature

we can easily allow for this factor.

If, then, we know how much uranium there was in the rock when it was formed, we can tell by the amount left how long a time has elapsed since that event. We can ascertain the amount originally present by measuring the residue left, for each atom of uranium ultimately leaves a residue of lead. I say ultimately because there is a complication. The disintegration of uranium is not quite as simple a process as the popping of corn, although in both cases, to be sure, gas and energy are set free. In the uranium explosion the result is an atom of another element which is much less stable than uranium and explodes in its own turn. In it the number of explosions per number of atoms present is much greater, and the time when the atoms are half gone is proportionately shorter.

This new atom derived from the explosion of an atom of uranium in turn changes into another, and this into another, until we have a whole staircase of descent in the course of which eight atoms of helium are given off. At the bottom of the staircase is lead. Ionium, radium, radium emanation, and polonium are among the elements formed in this process. In all there are about 17 of them.

We may compare the process, as shown, to the flow of water from a great tank of uranium, through a series of smaller tanks with outlet pipes of various sizes. The larger the outlet pipe in a tank the less water will remain in it at the end of a given period of time. The lowest reservoir is lead—"radio-lead"—differing from ordinary lead in no obvious respect. But its atomic weight is 206, whereas for ordinary lead this atomic weight is 207.18.

Thus any mineral or rock which contains uranium has always some lead as well as radium in it and, while the ratio of uranium to radium approaches a fixed value, the older the mineral the greater will be the proportion of lead present. If we multiply by the fraction 238/206 we will get the original amount of uranium present—provided we can assume that all the lead came from the uranium; otherwise we should get a greater figure for the age of the earth than the true one. In this way Professor Henry Norris Russell of Princeton figured that the solid crust of the earth could not have been solid for over 10,000,000,000 years. This quite accords with the astronomic estimates that the earth as daughter of the sun can not be over 1,500,000,000 to 5,000,000,000 years old, as given by Jeans and Jeffreys of Cambridge; and by Holmes of Durham University who gives three ways of estimating it.

However, part of the lead may be original, part derived from actinium or from thorium, for there is another family of radioactive elements whose grandparent is thorium, and thorium decays about a third as fast as uranium. If we could tell just how much of the lead was derived from uranium, how much from thorium, and how much was of other origin, we could then check up on our estimates. Aston of Cambridge has shown a way of determining this, although it is not yet very precise.

To make sure that the lead is derived from uranium its atomic weight must be determined. Even then we have to be reasonably sure that there was not originally uranium lead present. For certain crystals it is not likely that there was more than a trace of original lead of any sort, and Davis of Reno and Hall and Richards of Harvard showed that for the oldest rocks of the Black Hills of Dakota—older than any well defined fossils there—the radio lead is nearly one quarter of the uranium left. This means an age of 1,667,000,000 years. Assuming that the uranium disintegrated in the past at the same rate as at present, Ellsworth of Ottawa has shown in the same way that the oldest rocks in Canada are over a thousand million years old.

Miss Gleditsch of Oslo, Norway, who has worked with Madame Curie, and Ellsworth; also Riss and Kirsch of Vienna; Holmes; and writers cited by these scientists—all have shown similar great ages for the oldest rocks in various parts of the Old World, and it is in some such way that Sir Edgeworth David, Professor of Geology at the University of Sydney, Australia, estimated the ages of the rocks to which he has recently called public attention.

As we have stated, uranium contains more than one element and the presumption is that these different elements would disintegrate at different rates. Therefore those which did so most rapidly would the soonest disappear. This leads us to infer that the present rate of disintegration is less than in the past. Probably some allowance is to be made on this score, but reason will be given for the belief that this will not shorten the time by more than a small fraction of the total, and that the ages of rocks and minerals will be relatively the same.

Radioactivity and the radium discovered by Madame Curie were first studied in the products of a mineral known as pitchblende, from Bohemia. In this mineral the ratio of radio lead to uranium is but 0.028. This would imply an age of something like 200,000,000 years—not much over one tenth of the age of the consolidation of the crust. A number of tests of minerals from various places—minerals which were formed during that great series of crustal disturbances that ended the Carboniferous Period and formed the Appalachians; also crumpling the coal beds from Alabama to Rhode Island and from Wales through Belgium to Russia—point to similar ages. On the other hand, R. C. Wells, of the United States Geological Survey and M. F. Conner have recently shown by the lead-uranium ratio that the close of the Cambrian Period or "age of trilobites" was something like twice as far removed in the past.

That these estimates of great geologic times are justified is indicated by the results obtained from other methods of computing the earth's age. If, for example, we liken the estimation of geologic age by comparing the amount of uranium and lead to the estimation of the time that a pop-corn machine has been running, by determining the proportion of popped and unpopped corn, we may also liken estimates of the age of the rocks by the amount of helium gas which has been generated as described, to an estimate which should correctly measure the steam given off by the explosion of popped corn. Of course, helium gas thus generated is likely to diffuse away and give us estimates which are too low. Yet even these estimates give ages of several hundred million years. Dean Moore (Purdue), and Bennett are using this method.

A STILL more interesting method which is employed might be likened to seeing how battered up the pop-corn machine was, or counting the dents in the machine made by the flying corn. When an atom of a radioactive element explodes it sends the helium particle flying with a velocity which may carry it several inches. In solid substances, however, it has a much shorter range. The more frequent the explosions, the more violent they are, and the greater the range of the helium "bullets."

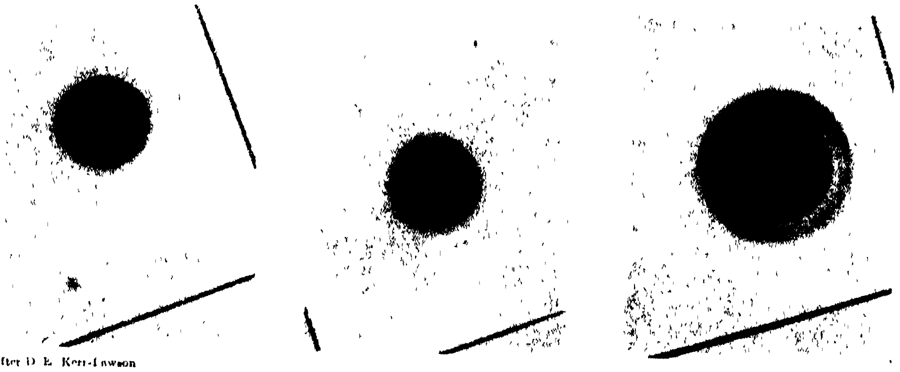
Now these helium "bullets" can do a good deal of smashing up and discoloring of molecules, especially toward the end of their flight when they have lost a good deal of their velocity, even as a rifle bullet with a high velocity may make a clean small hole in a window pane but at a low velocity may shatter it. The result is that a minute particle of a radioactive mineral embedded in mica, for example, is likely to be surrounded with a halo. Careful investigation may disclose not merely one darker ring but several, each corresponding to one particular element of the series shown, which in its explosion sends off helium bullets with its own particular velocity.

A photograph of these rings in the fragments of a very old Canadian rock, from a paper by Dr. Kerr-Lawson of the University of Toronto, is reproduced. The diameter of these rings matches very well the diameters which would be formed at the present date, and this is one reason for believing that a more rapid decay of uranium in times past is not likely to be very important in our calculations; for if it were it would show more in the diameter of the rings. Joly, of the University of Dublin, one of the greatest of the observers in this field, does believe there is a slight difference, in that the older rings are larger. But if so the amount is only some thousandths of a millimeter, and another explanation has been suggested even for this.

As yet no definite ages have been obtained by means of the ring method just described, since we do not know exactly how much radioactive material there may be in the minute specks which produce the halos. However, estimates even for the small fraction of all geologic time that has elapsed since the Devonian Period, give us a possibility of hundreds of millions of years.

The radioactive elements give us the most trustworthy estimates of ages, because, so far as we know, the rate of change seems to be the least variable of all the common methods of estimation. Most of the other forty-odd methods give us much shorter estimates of the duration of the geological periods. Here, however, we know that the rate of change is variable, and in many of them it is very imperfectly known.

Take, for example, the method by which the age of the ocean, stated as some 90,000,000 years, was estimated by the time needed to accumulate the salt in it at the present rate at which the rivers are bringing salt into the ocean. We doubtless know within a few percent the amount of salt in the ocean and the amount of water that yearly goes into it, but the analyses of the water are very uncertain both in their accuracy and especially, as Collins of Washington shows, in that they do not represent fairly the amount of water which goes off in floods. This is a very large proportion of the total run-off. The analyses have not been weighted in proportion to the amount of run-off they represent, and the estimates of the average percentage of salt in the river water may be two or three times too great. Moreover, the continents are now, as the Yale geologist Schuchert tells us, much larger than they generally have been in the past. Again, in the Ice Age which ended (or apparently ended) only a few thousand years ago, a lot of unleached rock was exposed to leaching. Finally, man, with his many activities and his salt mines, adds salt to some of the rivers and, in fact, may be traced by the extra salt he introduces into the water.



After D. E. Kerr-Lawson

DISCOLORATION HALOS ON MICA, PRODUCED BY FLYING ATOMS

Such halos are microscopic and, as seen on paper or on a thin sheet of mica, are really cross-sections of spheres or concentric shells produced by the helium atoms shot out at differing (hence the different rings) speeds. They are often called "pleochroic" halos, also

Thus, it may be assumed safely that the accumulation of salt in the ocean is now going on more rapidly than it was in the past. The 90,000,000 years just mentioned would be surely a minimum, except for the fact that we do not know how much salt there may have been in the ocean in the beginning.

THIS brings up another kind of uncertainty. In our estimates of geologic time we start at the present, and the farther back we go the more unlike present conditions the conditions then must have been. This applies to all the "hour-glass" methods; that is, those that depend on actions that go in only one direction. These are "one-way streets." We can tell the age of a horse by the amount that his teeth are worn down; we try to tell the age of a mountain range by the way the folds of the strata have been eroded away; we can estimate the time taken for Niagara to cut a seven-mile gorge at the rate of five feet per year. But each of these actions represents but a comparatively short fragment of geologic time—too short a fragment for accuracy.

Those of the earlier estimates of geologic time which were arrived at by considering the cooling of the earth and sun, have ceased to be thought worthy because most of them assume a cooling from some particular uniform temperature. But probably these temperatures never were uniform. Modern astronomy leads us to think that the temperatures may have been much higher at the earth's center than those outside near the circumference, or than those assumed by Lord Kelvin. The higher the temperature, the longer would be the duration of cooling. Moreover, these methods have ceased to be of value because the radioactive disintegration which we have mentioned furnishes a source of heat which indefinitely prolongs the cooling process. In fact, if there were as much radioactive material throughout the whole earth as in the surface granites the earth would heat up and would be likely to melt and explode.

This brings us to a most interesting and recent method of estimating the age of the earth. It is not probable that the earth is as radioactive all through as at the surface, for meteorites, which are believed to correspond in composition with the interior of the earth, are not nearly as radioactive as granites, which correspond to the outer rocks of the continents. Yet it is quite possible that an excess of heat is produced within the earth, above that which is constantly leaking through the crust. This heat accumulates and weakens the crust until there is a rather sudden yielding, then the excess heat comes out in a comparatively short time in a volcanic outburst and in the upheaval of mountain ranges. This would be something like the intermittent escape of steam from the lid of a tea kettle; or more like the discharge of the heat which slowly accumulates at the bottom of a geyser tube and discharges, say, once an hour.

Professors Holmes of Durham and Joly of Dublin have estimated that such paroxysms occur about every 20,000,000 years.

THE question then arises; how many such paroxysms can the geologists recognize? Holmes believes he can identify 20 in the better known part of the geologic rocks. We have here a method of measuring geologic time by cycles, due to a combination of a progressive action with paroxysms nearly at regular intervals. But we do not know how regular the intervals are.

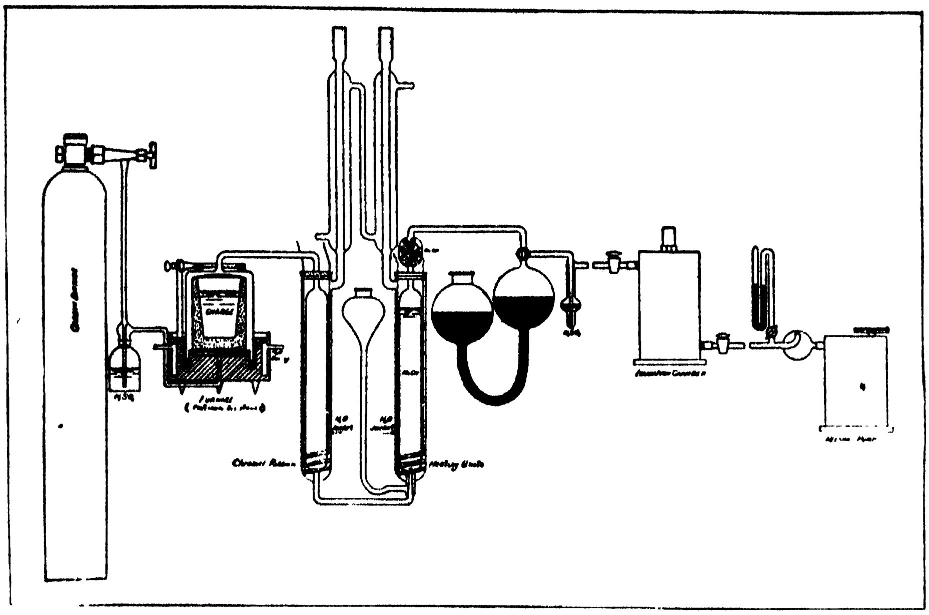
It would be ideal if we could associate geologic time, as we do the ordinary time of history, with regular astronomic cycles. For a short and recent duration this has, indeed, been done. Professor Ellsworth Huntington of Yale, lying on his stomach all one summer, measured the rings of the big trees of California. These rings are larger in rainy years. Thus he has carried back their annual record of climate to the famine which took place in the days of Elijah. Professor De Geer of Stockholm and his students, Antevs, and others, have similarly studied the banded, that is "varved," clays with an alternation of coarser clay deposited in spring, summer, and fall and very fine clay settling under the ice in winter, and has thus carried back the tale more than 12,000 years to the time when Sweden was mantled in ice.

It would be an interesting thing if we could recognize in the strata of the earth, varves due to the effect of changes in climate that take place in longer astronomic cycles than a year. At present when it is summer in the northern hemisphere the earth is farthest from the sun; it is nearest when it is sumer in the southern hemisphere. Some 13,000 years from now the reverse will be true. Gilbert and Kroll have studied the possible climatic effects, and more recently the Englishman Stamp thought he found in the Miocene Epoch strata of Burma a change in the character of beds which was due to this 26,000 year cycle. Thus he computed over 2,170,000 years for the time taken to form a series of beds that represent but a fraction of a later period of geologic time.

Again, at present the earth's orbit is nearly circular, so that from the September equinox to that of March is only three days shorter than from the March equinox to the September equinox. But there are times when the difference is more than a month, and the earth's orbit is much more elliptical. It is conceivable that one may detect the effect on climates and on the strata laid down when these changes take place in a much longer cycle. It is also conceivable that the whole solar system, traveling through space, might periodically pass so near to some star that the event would record itself in the story of the rocks.

HOWEVER, with a possible exception of the 26,000 year period—our so called "precessional period"—no such cycle has been identified, though Luyten, the Harvard astronomer, has been studying the distances and the motions of the nearest neighbors of the sun.

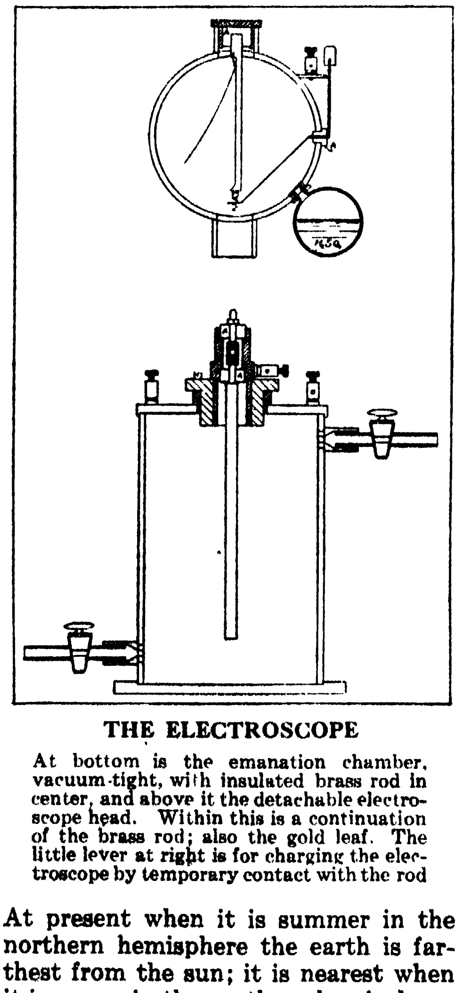
The continuity of life and the balance of the earth's climate between the two exterminating extremes in temperature is one of the marvels of the geologic story that suggests a guiding intelligence. The identification of longer cycles, either astronomic in nature or produced by the periodic accumulation and discharge of heat due to radioactivity, is a task for the coming generation of geologists and astronomers. But it is certain that we have millions of years—hundreds of millions of years—in which to study.



Courtesy *American Journal of Science*, after Piggot

DIAGRAM OF APPARATUS FOR DETERMINING THE RADIUM CONTENT OF ROCKS

Rocks are heated in furnace, carbon dioxide picks up the radium emanations, the gases pass through the scrubbing towers and are dried and collected over mercury. A detachable gold-leaf electroscope (shown in the diagram below) on top of emanation chamber determines the ionization of the air, hence the degree of radioactivity of the particular rock samples chosen



THE ELECTROSCOPE

At bottom is the emanation chamber, vacuum-tight, with insulated brass rod in center, and above it the detachable electroscope head. Within this is a continuation of the brass rod; also the gold leaf. The little lever at right is for charging the electroscope by temporary contact with the rod

Rats

The Rat Is Such a Common, Familiar Animal That His Psychology Has Almost Been Overlooked. But Even a Rat Is Interesting

By CALVIN P. STONE, Ph.D.
Professor of Animal Psychology, Stanford University

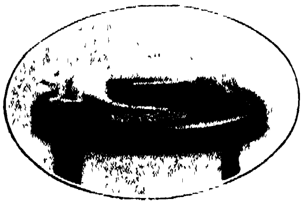
BIOLOGICALLY if not esthetically speaking the common rat is an admirable creature. Its ability to live in all parts of the world and for the most part against the will of man certainly entitles it to a high rank among the more efficient chemical engines of nature.

But hardiness and adaptability possessed by a pestiverous animal like the rat seldom win favor in the layman's thinking. While admitting the rat's efficiency for keeping in touch with his store of edible foods, at the same time he harbors an unqualified intention of lambasting him with a club whenever it is possible so to do.

In biological laboratories, however, rats have found complete asylum from those who would annihilate them when in the wild state. Strange to say it was by virtue of those same qualities that made of them the efficient pests of man, that they have now become the ideal subjects for many psychological and biological experiments. To increase the range of their usefulness scientists have found it to their own advantage to learn more of the psychological as well as the physiological make-up of rats. These psychological investigations have revealed facts that are most entertaining as well as useful.

ONE puts no great strain upon the imagination when he says that rats have coats of many colors but that they are totally unaware of it. By selective breeding tints, shades, and hues that are seldom or never encountered in the rat's native habitat have been produced. Of these the black and orange or straw yellow are probably the most striking and attractive. Esthetically speaking many people prefer the albino or the hooded strains, of which those with white bodies and black, brown, or yellow heads and similarly pigmented stripes along the back are the most common varieties. The pure albino, being the gentlest of all strains so far isolated, is for that reason a favorite in experimental laboratories. According to results of special investigations, rats are insensitive to what in ordinary terms is known as color. They can, however, discriminate with fair acuity small differences in shades and tints.

By native endowment the rat is fitted for a diversified education in a relatively complex and changing environment. Not only does he come into possession of a large repertoire of instinctive responses before or soon after the suckling period has ended, but in the course of a lifetime he forms and retains hundreds of habits and skills which enable him to cope with the individual characteristics of the native habitat. Some idea of the quality of the native equipment may be had by considering certain special phenomena of reproduction.



STRAW-COLORED RATS

By the common method of artificial selection rats of several colors have been bred

A farmer whose cribs and barns have become rat infested has ample reason to believe that the rat is psychologically and physiologically equipped for prodigious fecundity. Nevertheless the range of error in a conjecture of this character is unbelievable. Given ten virgin females and a couple of males, selected from a first-rate stock of well-nourished rats, an animal breeder, properly equipped and schooled in the moderns methods of husbandry, might reasonably expect to have 1500 healthy offspring on hand one year from date.

Within a year and a half this number could certainly be doubled, so strong are the reproductive instincts and so efficient the well-fed mother's care of young. Monthly increments and totals of animals on hand throughout the first year are shown in the chart. After all, however, adverse climatic conditions, unbalanced rations, food shortage, disease, and natural enemies probably are still man's greatest allies in withstanding the ravages of wild rats.

HOME ADDRESS OF RAT

Nest constructed by females for the care of their young. A bird builds a more systematic nest than this hodge-podge

Under favorable nutritional conditions the amorous life of both sexes awakens at the end of the second month of life. This, in terms of relative life span, corresponds roughly to the age of early childhood in man. The male is not a lazy drone in affairs of the heart, for his incessant philandering keeps him active from early adolescence to late senility. With the female, receptivity usually ceases before two thirds of her life course is run. Males are polygamous and females polyandrous. Incest is never a sex barrier. All provisions for the infants' care and nutrition are made by the female until the offspring are able to shift for themselves; thereafter family ties are speedily broken and forever lost.

WHEN not in captivity domesticated rats perform a wider range of activities in connection with the birth and care of their young than is usually found in the maternity wards of rat laboratories. This may be attributed primarily to lack of appropriate stimuli in the laboratory situations, rather than to a deficiency in the innate endowments of the mother, for when the latter is given a variety of nesting materials, allowed some latitude in the selection of nesting site, and permitted to avoid certain hardships and distracting stimuli of the surroundings her repertoire of maternal responses greatly expands.

A variable amount of nesting behavior is characteristic of all young adult rats of both sexes living in the wild state. Nesting contributes to the heat regulation of the body by conserving radiated energy when the temperature drops below the more comfortable ranges. To illustrate, an adult male which had always lived in a well-heated laboratory with no occasion for nest building was observed to build a nest for himself when his cage was temporarily put into a refrigerator for a period of approximately two hours.

Comparative studies of virgins and prospective mothers show that there is a great wave of nesting activity associated with or attendant upon the birth of their young. At this time nesting is more vigorous and persistent than at any other time of the animal's life. Even in the summer time when room temperatures are higher than those required for comfort of either the newborn or the mother it may be seen in all its characteristic vigor.

The nests are loosely constructed from whatever portable objects the animal may find. Upon analysis it is usually found, however, that the materials are poor conductors of heat. A sample nest mass constructed by a female from strips of various kinds of cloth, twine, hemp rope, and hair under laboratory conditions is shown in one of the illustrations. The supply permitting, a female carries new materials to the nest site daily and heaps them upon the total mass without attempting to place the individual pieces in any particular order or arrangement. Later she burrows into the mass and with fore-paws and mouth rearranges the materials about her until there is a fairly well formed pocket for herself and young. With only a limited supply of materials available an open top nest is usually constructed and maintained.

UNDER laboratory conditions many rats drag the food dishes to the nest site and push them upon the mound. On several occasions when the halves of condensed-milk cans were being used for food receptacles this tendency of the female presented some rather mysterious phenomena that we came to understand only after a bit of surveillance of the females' activities. Milk cans were found inverted over the mouths of the nests and young rats from five to ten days of age were closely packed into them like sausages of certain well known brands.

Our curiosity upon making this discovery raised the question as to whether the mothers were capable of this dexterous manipulation of young and, if so, what useful purpose it might serve either mother or young. Observation completely unveiled the mystery. The mother simply carried the can to the nest and rolled it upon the mass of shavings and paper of which the nest was built. If the open mouth of the can came to rest over the rim of the nest, the young, which crowd together like young pigs at a trough, crawled into the cans until all available space was occupied.

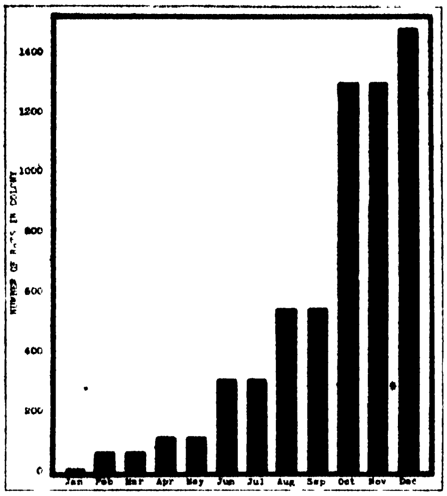
Another phenomenon strikingly absurd to the casual onlooker is seen among female rats whose nesting materials are very limited in amount. At times during the day, but more often at night, the female leaves the nest site and engages in search for more materials to enlarge or repair it here and there. On these occasions she sallies forth to all parts of the cage in search of bits of shavings, paper, or other portable materials.

Even when there is nothing more to be had, the search is continued for many minutes. It is then that the female, having gone to the farther wall of the cage, turns partially around and notices her tail lying on the floor before her. Picking it up in her mouth she starts for the nest, turning around and around until she reaches her destination, where it is deposited and shoved into place with her fore paws before starting on another forage for materials. Such stereotyped activities have been seen to be repeated over and over again in a single evening.

MANY actions of this type strongly suggest the presence of a strong inner driving factor back of the repertoire of maternal responses which finds expression in an abortive manner even though objects normally provoking these responses are absent and only poor equivalents are to be had.

In test situations female rats with new-born young show a remarkable range of ability to adapt their maternal behavior to sudden exigencies of the environment for which they have had no previous training or experience. When given the opportunity to choose between excelsior and pulverised dirt for the next site, the former is usually chosen. Likewise wood shavings are usually preferred to fine dirt. On the other hand dirt is usually selected when the only alternatives are fine sand or sawdust. Generally speaking, materials which admit of making the most stable nests are chosen.

If permitted to elect an illuminated or a semi-dark nest site, the latter is usually chosen. Among wild rats, hardly any exception to this rule is found. Both wild and albinos will frequently, although not invariably, move the nest and young back to the dark site daily if they are moved out into the light by the experimenter. You may recall that one seldom finds a wild rat's nest lodged in a well lighted place, as is the case with many of the well known ground birds. They hide their nests and young just as they themselves tend to hide from people and from animals which prey upon them.



OPTIMUM RAT PROGENY

Result from ideal breeding test, starting with ten selected females and two males

A RAINBOW OF VARIEGATED RATS BRED TO ORDER

Number 1 is an albino; 2 is straw yellow; 3 black; 4 brown or agouti; 5 black hooded; 6 yellow hooded; and 7 agouti hooded. Apparently the rats themselves are color blind

Under experimental conditions mothers will usually move their nests and young from strong currents of wind directed upon them, if cage facilities permit of such maneuvers. When air currents are daily directed upon the nests in their new locations, females will usually move nests and young to a quiet zone in relatively short order. Similarly, mothers repeatedly move their nests and young from a source of heat that is much too hot for bodily comfort.

EXPERIMENTS of the foregoing nature are of special value because they indicate the scope and quality of those inborn potentialities of rats, by virtue of which they are able to adapt themselves to very complex life situations. Facts of this nature, seldom coming to the attention of casual observers, help one to understand why the rat is able to perpetuate its kind the world over, even against a perennial host of adverse conditions which temporarily though never permanently hold it in check.

Bases for appreciating the marvelous adaptability of the rat also are to be had by considering it from the standpoint of its educability. Through experiments of this character we can plumb the rat's psychological makeup even better than by a consideration of its instinctive equipment.

The Radio and the Spectroscope

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

THE average citizen has probably never had much to do with the spectroscope, but he is likely to have a fairly good acquaintance with an instrument which is really of very similar nature; namely, a radio receiving set. Different as the two devices may appear, both are designed to separate from a multitude of radiations traversing the ether and falling upon the apparatus those of any desired wavelength, and to record their intensity and behavior.

The radio enthusiast demands two things above all of his receiver: it must pick up sufficient energy from the feeble waves which come from distant or low-power stations to give a clearly intelligible record, and it must be as free as possible from interference between stations operating on nearly the same wavelength. These two qualities, distance-reception and selectivity, are familiar in tens of thousands of households, and exactly the same things are what the astrophysicist desires in his spectroscopic outfit.

"DISTANCE" for him means the capacity to observe faint stars or nebulae. For stars this is primarily a financial question. The bigger the telescope which collects the star's light and feeds it into the slit of the spectroscope, the fainter will be the stars that can be reached with a practicable exposure time; so the great reflectors have this field practically to themselves. To get faint nebulae is a different matter. They are *patches*, not points, of light and a large telescope, although it collects more light, spreads it out into a large image most of which falls outside the spectroscope slit. Success here has come partly by ingenious design, concentrating the photographed spectrum on a small area, and partly by patience in making very long exposures.

Resolving power, as the spectroscopist calls the capacity to separate radiations of neighboring wavelength, is quite another story. To secure it one must design one's instrument so that the number of successive light waves which at any given instant are actually traversing the working part of the instrument is large. That is, if we use a prism it must be of considerable thickness at the base; if a diffraction grating, this must be big enough to have a large number of lines. Practically speaking, then, high resolving power demands a large spectroscope.

When enough light is available, as in solar work or in the laboratory, spectroscopes are often made very large, and spread out the spectrum so widely that the red and the violet are many feet and even yards apart. With the stars, of course, this is impracticable, and a compromise must be struck between the intensity and resolution of the spectrum. A great telescope may have half a dozen auxiliary spectroscopes. The faintest stars will be observed with a small instrument giving a spectrum perhaps a quarter of an inch long, showing a dozen or two of the strongest lines; the brightest with one which yields spectra more than a foot long, on which thousands of lines can be distinguished.

In actual selective power even a small spectroscope surpasses the wildest dreams of the radio enthusiast. It is a poor instrument that will not clearly separate the yellow sodium lines which differ in wavelength by about one part in a thousand. If radio sets could be made as good they would not be seriously troubled by interference between two stations working on wavelengths in the broadcast band different by half a meter, and the tasks of the radio commission would be much less perplexing than they are now. A really powerful spectroscope will do a hundred times better than this, and may be likened to a radio device which would permit of the inclusion of all the present American broadcasting waves within a single kilocycle. (Certain complications obvious to the radio expert which arise from modulation of the waves in broadcasting would make any such result unattainable in practice, however perfect the receiving and sending sets.)

WITHOUT this high resolving power there would have been no hope of observing more than 20,000 separate lines in the solar spectrum, each carrying its own message concerning its origin. Some of the 57 elements which have been identified in the sun are revealed only by faint lines which, with an instrument of low resolving power, are so "fuzzed" out as to be lost altogether. Others are detected by lines which lie so close to stronger neighbors that only a high resolving power will separate them. Even so, there remain many blends of lines which lie too close together for our best spectroscopes to separate. In stellar spectra, where less power can be employed, such blends are often the rule rather than the exception. It is no wonder therefore that observers never cease to desire instruments of still greater resolving power.

We know, however, that nature will sometime set a limit to such an advance. Could we make receiving instruments ten times as powerful in this respect as the best set we have now for working on the sun we would not gain proportionally. For there comes a time when we must consider what the sending instruments are doing.

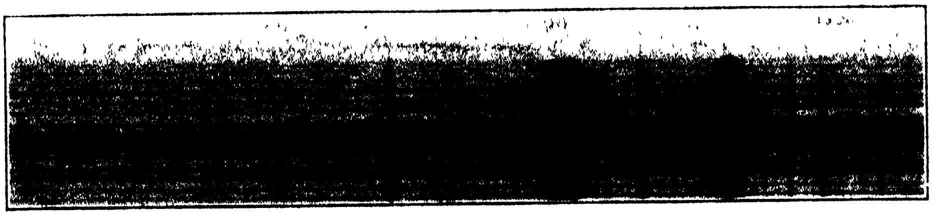
These "instruments" in the sun or the stars are the innumerable atoms which compose the heated gases of the upper atmosphere and absorb from the

Photo by S. A. Korff, Princeton University

APPARATUS FOR STUDYING WIDTHS OF LINES

1, Base of Michelson interferometer; *2*, its end mirrors; *3*, its center mirrors; *4*, tube containing sodium or other vapor to be studied in absorption, with central heating coil and water cooling to protect end windows; *5*, source of light, a 1000-watt bulb; *6*, spectroscope for observing or photographing lines Apparatus employed by Prof. J. Q. Stewart at Princeton radiation of the hotter layers below the upper atmosphere those wavelengths which correspond to the observed dark lines. The waves which they absorb are of just the same nature as radio waves, but an atom is by no means like the oscillating electric circuits of a radio receiver.

INDEED, no physicist dares today to say very much about the processes which happen when an atom absorbs light waves or gives them out. There is good reason, however, to believe that in the net effect an atom behaves very much like a tiny receiving and sending set of the simplest imaginable sort. We may picture such a set as a simple electron free to oscillate under the varying electrical forces of the light waves, but "tuned" in such a way that it responds naturally to radiation of one particular wavelength. The behavior of such an ideal "oscillator" is much like the more familiar one of an ordinary radio receiving set. We all know that, when a set is correctly tuned to the wavelength of a powerful station, the response comes in loud and strong. Our set is absorbing a large amount of energy (relatively speaking) from the incident waves. But if we put our set a little out of tune with the station we do not lose the response wholly. It fades away gradually as we turn the dial and sometimes remains strong enough to interfere seriously with weaker signals of somewhat different wavelength; that is, our set still absorbs some energy from waves for which it is a little out of tune, although less and less as we go farther out.



Courtesy Mount Wilson Observatory

A GOOD EXAMPLE OF "WINGED" LINES

A section of the sun's spectrum near the D lines of sodium. The Fraunhofer lines run up and down and the horizontal streaks may be disregarded for the present purpose. The two strongest lines are due to sodium. Their great width is due to "broad tuning" and to the fact that sodium is relatively abundant. In 1924 Stewart calculated that the number of sodium atoms concerned in these lines is of the order of 10^{16} per square centimeter column in the solar atmosphere. The less intense lines are due to atoms of other elements

The better designed our set is, the narrower will be the band of interference on each side of the wavelength of the powerful station. But perfect tuning is impossible. Even the ideal oscillator, consisting of but a single electron, must have its own region, although very narrow, in which it responds to and absorbs radiations to which it is not exactly tuned. Atoms in a star's atmosphere therefore, even if they behave as well as the idealized systems just described, should not give an absolutely sharp absorption line. Exactly at the right wavelength for which they are tuned they will absorb very strongly and give a very dark line, but a little to each side they will still be absorbing—although ever more weakly—and the observed line will therefore not be sharp but bordered by "wings" gradually fading away into the bright background.

Now all the stronger lines in the solar spectrum (where we can use resolving power enough to make sure that our spectroscopes are not to blame) actually show this winged appearance. For the heaviest, like the great H and K lines of calcium in the violet, the effect is conspicuous on ordinary photographs, and it is easily visible for many others in spite of the fact that spectrum photographs have usually been exposed and developed in such a way as to secure the sharpest detail—that is, to cover up the effect under consideration.

IT was formerly thought that this widening of the line was due to rather high pressure in the sun's atmosphere (since in the laboratory the lines produced in gas at high pressure are widened). But more careful study showed that under pressure some lines of iron, for example, are far more widened than others of equal strength, while this is not at all the case in the sun. It appeared, in fact, that the widened or winged lines in the sun's spectrum belonged to just those elements which there is good reason to believe are the most abundant, and that the strongest lines of each element are the most heavily winged. This made it clear that these wings depend mainly upon the number of atoms which are at work in producing the line, and this is exactly what should be expected on the basis of electrical analogy. The more atoms there are at work on the line the more will be working a greater amount of time, and hence the more light will be absorbed at a given distance from the center of the line, and the wider the wings will be.

Here then is a new way of studying the sun's atmosphere. It is not merely possible to explain why some lines are wider than others but to calculate how many of the tiny idealized oscillators would be required to produce a line with wings of a given width. The calculations, which were just made by Stewart at Princeton and extended in fuller detail by Unsöld, show that the width across the wings of a line (measured for example from the points where 10 percent of the light is absorbed) should be proportional to the square root of the number of oscillators which were at work. This prediction can be tested, for there are a number of pairs of lines, such as the D lines of sodium or H and K of calcium, for which we have good theoretical evidence that twice as many atoms are at work producing the stronger line of the pair as in the case of the weaker. We should therefore expect the width of the wings to be 41 percent greater for the stronger line.

THE actual widths of the lines are very different, indicating that the numbers of atoms or at least of "effective oscillators" which are at work are very different. To produce the strongest lines of all, H and K, Unsöld finds that 27 x 10^{18} (27 billion billions) of atoms should be required above every square centimeter of the solar surface. The strongest lines of sodium and aluminum demand only about a thousandth part as many. These numbers of atoms are enormous but a cubic centimeter of air under standard conditions contains 27 x 10^{18} molecules. So the calcium vapor in the sun's atmosphere, if compressed so as to be comparable with air under standard conditions, would make a layer less than half an inch thick, and the vapors of sodium and aluminum vastly less.

In the latter cases allowance must be made for the fact that these elements are largely ionized. But even so, the conclusion seems inevitable that the whole quantity of these metals, which are among the most abundant in the sun's atmosphere would, if taken together, make a layer of gas under standard conditions only a few inches thick. As the actual atmosphere of the sun is hundreds of miles deep it must be of extraordinary tenuity.

There is plenty of other evidence to prove this, but none more convincing. There is indeed no need of elaborate calculations or advanced physical arguments. Sir Norman Lockyer more than 50 years ago pointed out that stronger absorption lines are produced by passing light through a flame less than an inch thick and containing a very small percentage of sodium vapor than appear in the whole spectrum on account of the action of all the sodium vapor in the sun's atmosphere.

Sodium lines are nevertheless among the strongest in the solar spectrum (excepting H and K). Lockyer's conclusion that the sun's atmosphere must be of very low density, although forgotten for many years, was entirely correct. *Pontresina, Switzerland.*

THE VALLEY OF MARBLE

The Green Mountain area contains some of the finest marble quarries in the world. They are now developed with the aid of powerful electrical and other machinery and production is on an efficient basis. Some of the marble comes from a depth of 320 feet below the surface

Quarrying Marble, the Token of Eternity

Ancient As the Everlasting Hills, Marble Furnishes a Lasting Material for Building Construction and Memorials

By A. E. HOLDEN

WHEN man first sought to perpetuate the memory of a great deed, a noble life, a sincere devotion, he turned to the everlasting hills. There he found no useful stone more inspiring, more beautifully simple, or more enduring than marble. The world's oldest statue and its oldest inscription tablet are of marble. The first, believed to be the replica of an ancient Babylonian king, was discovered by Dr. Edgar James Banks of Chicago University among the Bismya ruins of the Mesopotamian desert. George Byron Gordon discovered the marble tablet, its inscriptions still intact after nearly 60 centuries, in the ancient Chaldean city of Ur.

The tradition of the excellence of marble was ancient when the "Golden Age of Pericles" and the reign of Augustus in Rome achieved those classic works of art and architecture which have set standards of design for all the modern world. Nations, states, and families, illustrious and humble, still carry on the tradition by using this pure, inspiring stone for memorials which will pass on to succeeding generations the record of their noblest devotions.

Geologists claim that at one time the whole Green Mountain area from the St. Lawrence to the present site of New York City was under water. Then the shell fish and lime-producing animals began the work of building marble beds. Ages afterward there came a wrinkling of the earth's crust, which displaced the water with mountains and valleys and gave to the Atlantic a new shore line. Thus was Vermont marble formed and buried in the earth. For ages it lay undisturbed.

Before the Revolutionary War, someone split the first slab of American marble from the ledges of Vermont and used it for a fire-place hearth; others heard about the new material, and carried away, in ox carts, the attractive, heat-resisting stone. In the old churchyard at Bennington, Vermont, is a marble tablet which has weathered the storms since 1768 a space of 160 years. It was raised in memory of John Pratt, and unquestionably was one of the first pieces of Vermont marble to be placed in the cemetery.

IN those days, the marble trade was handicapped through a lack of suitable machinery, transportation facilities, and other trying obstacles, until in 1870, there entered the field a man who took a slipshod mill and a half-developed quarry and organized the Vermont Marble Company.

Let us start with the unopened quarry and trace the methods of raising the marble from the Vermont mountains and making it ready for the market. The experienced quarry hunter, when he finds a promising spot, calls for the coring machine, with its revolving drill, pointed with diamonds, which may be sunk to practically any depth. By this means, a cylinder of stone two or three inches in diameter may be taken out, which shows the structure and quality of marble through which the drill has passed. When the conditions warrant further development, a varying amount of waste must usually be removed before sound marble can be reached. The cost of this work frequently amounts to 50,000 dollars.

After more or less dirt and rock have been dislodged and carried away—a process which calls for careful and systematic blasting, the marble floor is ready for the channeling machines. The channeler runs on a movable track, and cuts a groove about an inch in width. When it approaches the end of the track, it is automatically reversed. Thus it goes on cutting its way downward until the groove has been lowered to a depth of several feet. The work is done by five chisel-pointed drills, clamped together in a row and attached to the end of a long bar. The resistless up-and-down motion of the bar forces the row of drills into the heart of the marble bed.

When the quarry floor has been lined with parallel grooves of the required depth, the channelers are run across at right angles, dividing the strips of marble into squares. The quarry blocks thus formed are known as "key" blocks and are broken off at the bottom by drilling and wedging. After the key courses have been cleared away, the remaining blocks in the floor are split out, at both the sides and the base, by the same process of drilling and wedging.

There are several ways of removing blocks from the quarries. At Danby Mountain, the marble is brought down over a mile of cable track, a drop of about 900 feet. At the West Rutland quarries, a part of the blocks are raised by derricks; others are drawn over an inclined cable track. This track is 500 feet long, and rises at an angle of 45 degrees. On the quarry floor, 300 feet below the surface, it connects with under-ground electric roads which extend 800 feet into the tunnel.

Once the marble is loaded on cars, it is ready to go to the mills. The modern marble mill is constructed of steel. A track, over which the stone is brought in, runs from end to end of the structure. The adjoining space is divided into stalls, any one of which will accommodate a large quarry block. Sawing is done by smooth iron bands, set in a moving horizontal frame, and acting in conjunction with sand and water.

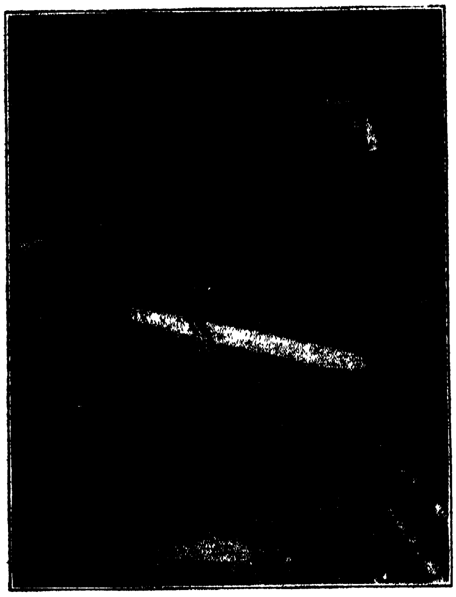
WHILE the soft strips of iron drag to and fro across the marble, the water pours over the top of the block, bringing the particles of sand which serve as teeth for the saws.

In the days of the old mill, a few teams could haul all the sand that was needed. When the business increased, a short cableway was constructed, but the buckets soon began to come back empty. Finally, the cable was extended for two and a quarter miles over the mountain to a larger sand deposit. It now brings in sand at the rate of 500 pounds every 28 seconds.

On leaving the mills, some of the marble goes directly to the monumental shops, some to the building department. If it comes out in the form of thin slabs, it will probably be used for interior building work. Within the shops it may go into one of the large lathes—for marble, like iron and steel, can be accurately turned—or it may be taken to one of the planing or molding machines.

If it is too large, it can be placed under the diamond-disk saw. The rim of this saw contains approximately 125 diamonds, and will cut the hardest marble, if it is well supplied with water. By far the larger part of the marble is delivered at the rubbing beds. There it is held in a fixed position on the surface of large revolving iron disks. The sand and water, which are spread over these disks, take away the roughness and irregularity from the marble faces. Then it is ready for the cutter and polisher.

The marble cutter of today can do almost anything with pneumatic tools. He still uses the hammer and mallet now and then—there are times when they are safer and more satisfactory—but ordinarily, the modern workman, even the carver who executes the finest of sculptured work, turns to the chisel that is driven by compressed air.



FOLLOWING A VEIN OF MARBLE

Here marble is quarried at a depth of 320 feet. The lateral pressure is resisted by immense reinforced concrete struts as shown

MARBLE is available in a variety of finishes, and much of it is finished entirely with pneumatic tools. This process often takes the place of sand, hone, or polish. Marble for the interior of the building is usually given a high polish. Large flat surfaces can be polished by machinery. Curved and molded faces must be rubbed down by hand. The polishing machine is a small whirling plate attached to a movable arm. These plates are of several kinds. Like the saws and the rubbing beds, they must be given plenty of water, but they use no sand. The one first employed is coated with carborundum; the second has a face of aloxite; the third is made up of fine hone-stone. The hone finish, which is a sort of dull gloss, is one that is often specified, especially for monumental work. The last plate is covered with felt and is used in connection with polishing putty. In hand polishing, the process is much the same, although more time is required to complete the work.

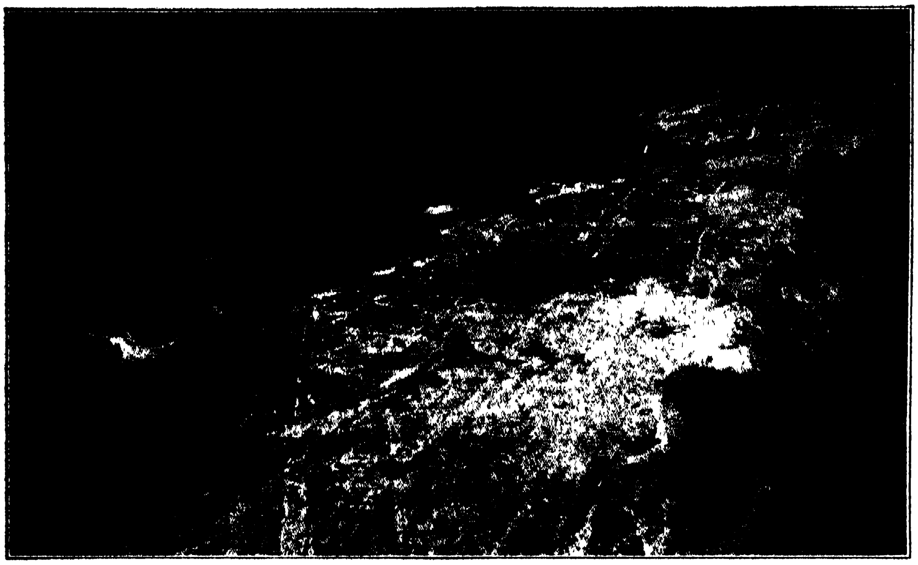
The "Wellhole," a comparatively recent opening on the West Rutland vein, has, as its name implies, a small opening at the top through which the blocks are raised to the surface. Quarrying in the West Rutland deposit began about the year 1844. The financial results at first were not encouraging. In fact, it took over 30 years to bring these quarries to a satisfactory state of development. In recent years from 400,000 to 600,000 cubic feet of marble have been removed each year, and there is still an almost unlimited quantity available.

Not counting the various grades of blue marble which lie to the west of the white deposit at West Rutland, this remarkable vein produces 15 different grades of marble for monumental and interior building purposes. These range from the almost pure white to the dark greens.

The obstacles surmounted in the

IN THE UNDERGROUND QUARRY

Huge piers serve to sustain the roof while the electric railway brings the quarried marble to the "Wellhole." It took 30 years to develop these quarries for profitable production



GLACIAL SCRATCHES

This outcrop of marble is interesting on account of the glacial scratches which show that the marble was in place before the great ice cap scraped the hard stones over the soft marble

Pittsford Valley quarries at Florence, Vermont, are suggested by the illustrations. Following a comparatively narrow vein of marble to a depth of 320 feet, the tremendous lateral pressure is held in check by immense reinforced concrete struts. These quarries present to the architect and engineer one of the most interesting developments of the Vermont region.

The Pittsford Valley quarries produce large quantities for cemetery memorials and several varieties of interior and exterior marble. The quarries are notable for the large sizes which are obtainable. Blocks for monolithic columns measuring 32 feet long and over four feet square have been readily secured, the hoisting of pieces of this size being the major problem.

For the Bridgeport Savings Bank, the Pittsford Valley deposit furnished two of the largest caps ever finished in Vermont marble, each containing 117 cubic feet. The pilasters for this structure were made up in three sections, each piece containing 116 cubic feet. One of these blocks weighed 52 tons, another 55 tons.

Verde Antique is the standard dark green marble of America, and was first produced about 1850. The original quarry, located at Roxbury, Vermont, was operated in a limited way until 1893. The earlier methods were crude in the extreme and the quantity of marble produced was very small in comparison to the present output which, in 1924, was over 12 times that in 1901. During the last ten years, several new quarries, all in central Vermont, have been developed. Verde Antique occurs in isolated masses which, roughly, are of the shape of a double convex lens standing on edge. The marble is of such extreme hardness that the quarrying presents a difficult problem. The machinery is the same as that used in other quarries, but specially tempered cutting steel is provided. The finishing also presents an unusual problem. The bulk of this work is done at an especially designed and equipped plant at Swanton, Vermont. There at the lower falls of the Missisquoi River, where water power is available, are 24 saw gangs and a large finishing plant.

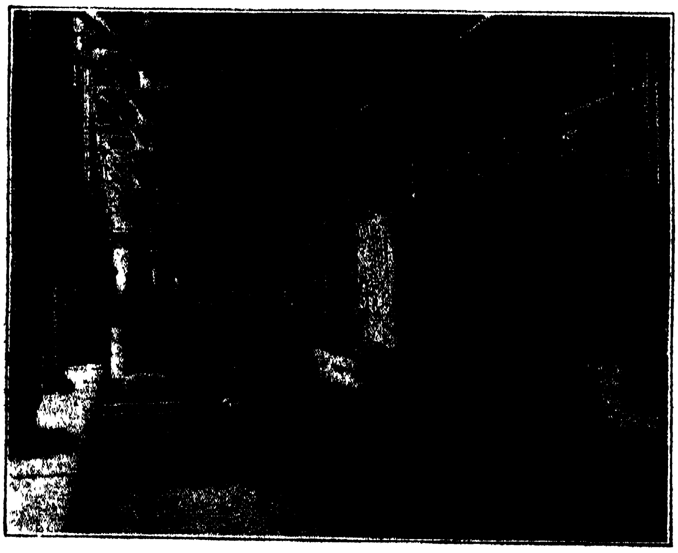
The early settlers in the vicinity of Danby Mountain discovered its deposits of marble and, from the outcroppings in the valley, split off pieces for memorials to their dead. Headstones bearing dates as early as 1765 are still standing, their crude lettering sharply defined in spite of the passing years. In 1836, at Erie, Pennsylvania, there was erected from the Danby quarries the first marble public building in America of which there is any record. Constructed originally by the United States Bank of Pennsylvania, it was purchased by the Government in 1850, and is now used as a Custom House. It is still well preserved.

As the demand for marble increased, quarries farther up the mountain side were developed, the blocks at first being drawn down by teams. This crude and dangerous method of handling finally gave way to an inclined railway, operated by immense cables. The steam cutting machines, which were first used, were replaced by modern electric channelers, and there was finally evolved the remarkable quarry development of the present day.

Tunnels have pierced this mountain to a distance of 400 feet, and lateral branches have been added until more than two acres of quarry floor with an average depth of 30 feet, are now furnishing blocks. The quantity production of marble whose quality has been proved by over a century of use is now possible. Storage yards always contain upwards of 15,000 blocks.

A 63-TON BLOCK

It is rarely feasible to quarry just what blocks are required for current orders but there are some exceptions and here is one



A MARBLE MILL

Giant lathes and planers machine the blocks and slabs for building or monumental purposes. Pneumatic tools are very largely used

Sea Safety Inventors Receive Their Reward

THE actual bestowal of the SCIENTIFIC AMERICAN Gold Medal, which had been awarded to Professor Reginald A. Fessenden by a committee formed by the American Museum of Safety, took place in New York City on November 7th last. A distinguished assembly composed of the Trustees of the Museum, the Committee, and invited guests witnessed the simple ceremonies. Mr. Arthur Williams, President of the Museum, presided, and the actual presentation was made by the Hon. Frances Perkins, State Industrial Commissioner. Unfortunately, Professor Fessenden was in Bermuda, owing to illness. In his absence, his son, Major R. K. Fessenden, received the medal and the framed citation signed by all the members of the committee. Referring to his father, Major Fessenden said:

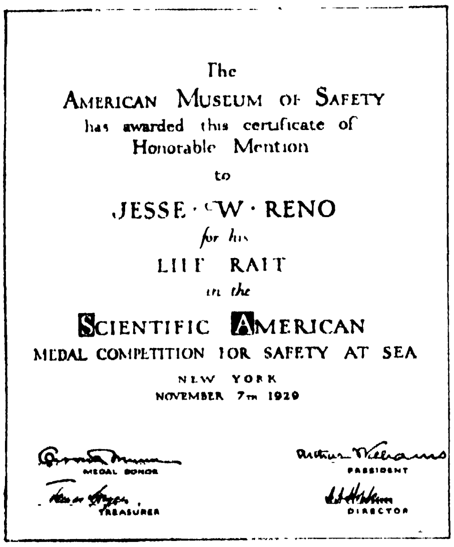
"His brain is as active as ever, but the strain of 40 years of invention forces him to conserve his energy."

Citations of honorable mention in the contest for the medal were presented to A. P. Schat of Utrecht, Holland, Jesse W. Reno, and J. Lyell Wilson, the latter two being present.

Other speakers included Louis S. Treadwell, representing the donor of the medal, which has now been awarded nine times since 1908 and three times for the promotion of safety at sea, and is soon to be competed for in another contest. Messrs. James Speyer, treasurer of the American Museum of Safety; W. D. Baldwin; Robert A. Franks; H. J. W. Fay; and Captain E. T. Fitzgerald, vice chairman of the committee of award, were among those also present.

THE MEDAL BESTOWED

The medal was actually presented to Maj. R. K. Fessenden, son of the inventor, by the Hon. Frances Perkins, State Industrial Commissioner of New York



The
AMERICAN MUSEUM OF SAFETY
has awarded this certificate of
Honorable Mention
to
JESSE · W · RENO
for his
LIFE RAFT
in the
SCIENTIFIC AMERICAN
MEDAL COMPETITION FOR SAFETY AT SEA
NEW YORK
NOVEMBER 7th 1929

MEDAL DONOR

Arthur Williams
PRESIDENT

TREASURER

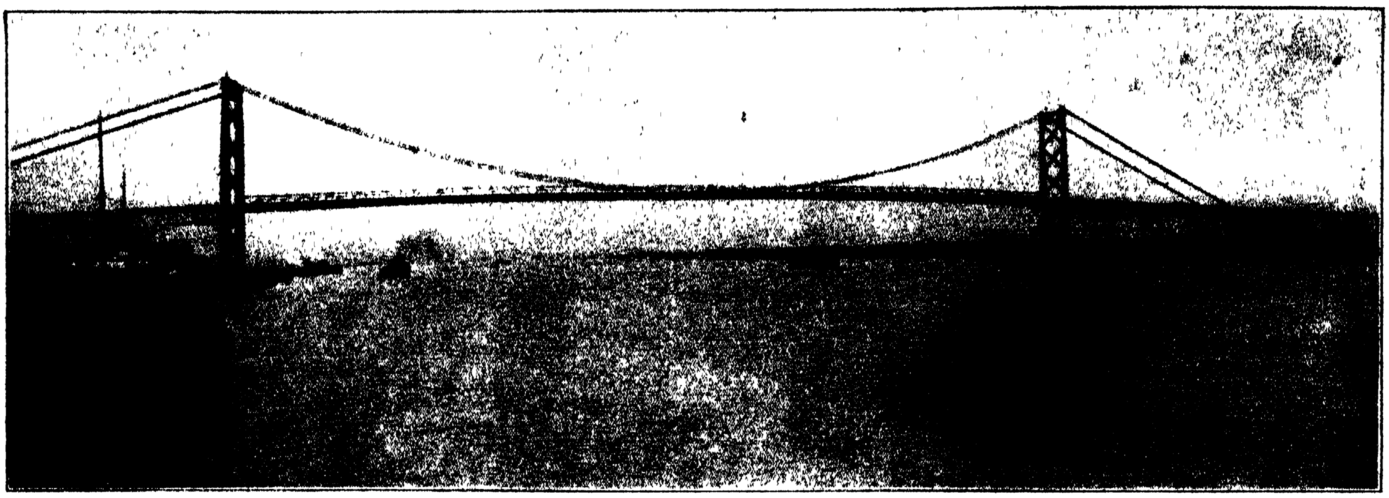
DIRECTOR

HONORABLE MENTION CITATION

One of the three Honorable Mention Citations. These honors were conferred at the luncheon. The winners are shown below

A GROUP OF DISTINGUISHED GUESTS

From left to right: Mr. A. A. Hopkins, Secretary of the Committee; Mr. H. J. W. Fay; Mr. A. Methofer, Consul for The Netherlands; Mr. Arthur Williams, President of the American Museum of Safety; Mr. J. Lyell Wilson; Major R. K. Fessenden; Hon. Frances Perkins, State Industrial Commissioner; Mr. Jesse W. Reno; Mr. L. S. Treadwell, Vice-President SCIENTIFIC AMERICAN; Mr. W. D. Baldwin; and Mr. James Speyer, Treasurer of the American Museum of Safety. The luncheon took place in the Union League Club, New York City



"BECAUSE OF, AND FOR, AUTOMOBILES"

Tremendous increases in automobile traffic, by ferry, between Michigan and Canada made this bridge necessary. It connects Detroit with the great Ontario peninsula between Lakes Ontario and Erie and cuts many miles from the trip north to Niagara Falls

The Detroit River Is Spanned

At An Extremely Important Point, Economically, a Beautiful Bridge at Detroit Has Largest Span in the World

BY F. D. McHUGH

BRIDGE engineering has reached such a stage of design today that one expects to find a certain massive beauty in any new span that rises. Slim skeletons of steel pointing skyward from river or river bank piers and holding high their thin webs which, in turn, support a gracefully curved floor, all seemingly conscious of the combined estheticism and utilitarianism that have been worked into their design by skillful engineers, grip the imagination and give rise to a feeling of pride in the works of man.

When, however, such a structure becomes also a new tie to bind two great peoples into a closer friendly relationship, when it serves to promote the exchange of raw and manufactured products, and when it removes another section of the physical barrier between one country and its best customer and source of outside supply, it has an added significance; it is a "most important contribution to international amity." Such a bridge is the appropriately named Ambassador Bridge over the Detroit River between Detroit, Michigan, and Sandwich, Ontario, which has just been completed and was dedicated on November 11, 1929.

TWO ANCHORAGES

Cutting away the concrete from around the cable terminal eye-bars. This shows the manner in which cable terminals and eye-bars are finally embedded in massive concrete

WITH the longest main span of any suspension bridge in the world at the present time, the Ambassador Bridge was built because of and for automobiles. In the olden days the missionaries Brebouf, Chaumonot, de la Richardie; the explorers Joliet, LaSalle, and Cadillac; the chieftains Pontiac and Tecumseh; and the generals Brock and Harrison had to cross the natural barrier of the Detroit River in boats. With the rise of the so-called border cities there was much agitation for the bridge. Just prior to construction of the present bridge, a bridge to include a deck level for railroads was contemplated and almost decided upon; but this, along with other bridge ideas, had to be abandoned because of the tremendous increase of automobile and bus traffic. The completed bridge provides primarily for automobiles and incidentally for pedestrians.

The location of the new bridge is unique in that three great general trade routes intersect at this point. These are the Canadian routes from the north and west which terminate in the east in Montreal, Quebec, and other eastern Canadian points; the American trade lines from east to west across the peninsula and eastern Ontario; and the Canadian-American trade route connecting the Canadian east with the American middle west, far west, and south. Thus it will be seen that the location has the economic significance of the famous caravan cities of the ancient Oriental countries.

DURING a recent six months' period, customs figures show that 135,000 tourist cars crossed the border at this point while the estimated total, including holiday and week-end visitors, was 675,000 cars. With an average of four and a half persons per car, this would give a traffic of around 3,000,000 passengers during that period of time. It is anticipated that completion of the bridge will tend to increase this traffic to a very large extent because of the fact that from any point north of Chicago, the bridge route to

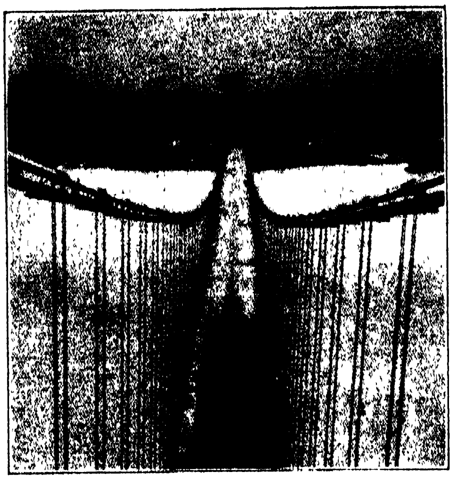
Niagara Falls is very much shorter than the route by Cleveland, as shown by the following table:

To Niagara Falls From	Via Bridge	Via Cleveland	Saved
Detroit	254	391	137
Chicago	543	578	35
Grand Rapids..... ..	401	505	104
Battle Creek.......	369	446	77
Kalamazoo	393	470	77
Fort Wayne, Ind. .	422	432	10

Many problems were encountered in preparing the plans for the new bridge. Early surveys were inaccurate; clearance of the bridge above water was first made too low, inasmuch as ship's masts have lately been made higher due to the demands of improved radio equipment; the span of the bridge was originally planned to be 1770 feet.

THE main span of the bridge is 1850 feet and the suspended floor clears the water 150 feet at the center and 135 feet at the towers. The bridge itself is 9000 feet long from the end of one approach to the other, 7400 feet of this being structural length. The Canadian approach is 2420 feet, while that on the American side is 1480 feet. The approaches on both sides spread out into wide plazas and each approach has nearly 30 customs and immigration gates for expediting traffic and preventing traffic tie-ups. There are two towers approximately 380 feet high above mean water level, each resting upon two 38-foot concrete cylinders. The dead load on each cylinder is about 20,000 tons.

Two great cables, each 19⅜ inches in diameter, support the roadway and stiffening trusses. These cables are swung on 67-foot centers and rest upon massive rocking cradles on the tops of the towers, these cradles being designed to take care of any expansion due to temperatures up to 120 degrees.



FROM THE CANADIAN TOWER

Cables, suspender ropes, catwalks, and floor can be seen in this view of the bridge

The total width of the suspended roadway is 55 feet, 47 feet of this being divided into five vehicular traffic lanes and the remaining 8 feet being a sidewalk.

Construction on the bridge began on May 7, 1927 and proceeded so rapidly that it appeared it would be completed long before the scheduled date of August 16, 1930. Then the unforeseen occurred.

The great cables had been erected; the two foot-walks used in spinning the cables had been removed, cut into sections, and the sections used as suspenders for holding the bridge floor; and a part of the roadway structure had been erected when news of breakages in a similar structure, the Mount Hope Bridge, was received. No important breakages had been found in the cables of the Ambassador Bridge, but they were assembled from a new steel wire exactly the same as that used in the cables of the Mount Hope Bridge and produced by a special heat-treating process. Therefore it was decided to scrap the cables before something serious did happen and replace them with cold-drawn steel wire that was known to be dependable for suspension-bridge work.

Riveted girders that had been placed at the roadway were taken down, new cables to hold two new catwalks were made ready, and the catwalks themselves put up. Then when the suspender cables had been removed, everything was ready for the work of dismantling the cables.

THE cables themselves were composed of 37 compacted strands of Number 6 galvanized wire, each strand containing 206 wires. Back at the anchorages the concrete was broken away so that the end of a strand could be gripped and pulled from the cable by means of a hydraulic jack. The removed strand was then cut with an oxy-acetylene torch into lengths of about 30 feet which were, in turn, hauled along the catwalk to the towers and then lowered by crane to be carried away and sold as scrap.

The cold-drawn wire of which the new cables were to be spun was ready when the process of disassembly was completed. This work of destruction had taken but 20 days. Spinning of the new cables proceeded rapidly and the bridge was completed long before the date originally scheduled for its completion. It was dedicated, as stated above, on November 11, 1929 and was opened for traffic on November 13.

The Ambassador Bridge is the property of the Detroit International Bridge Company. It is expected that tolls will pay for the structure within a comparatively few years.

All photographs courtesy George Harrison Phelps, Inc.

COMPRESSING THE STRANDS

A compressor similar to the one described in a previous bridge article, with radial hydraulic jacks, press the strands into a round section

WRAPPING THE CABLES

This machine wraps a binding of soft iron wire around the cables, 300 miles of wrapping wire being used

AN OLD MASTER'S CONCEPTION OF HELL

Christ's Descent Into Hell, by H Bosch, a Flemish painter (1462-1516). Early writers who wished to depict a horrible hell and thus frighten the common herd into better morals would doubtless have used with avidity the modern scientist's knowledge of heat and cold

A Modern Inferno

What the Civilized World Owes to the Scientific Research of the Modern Chemist

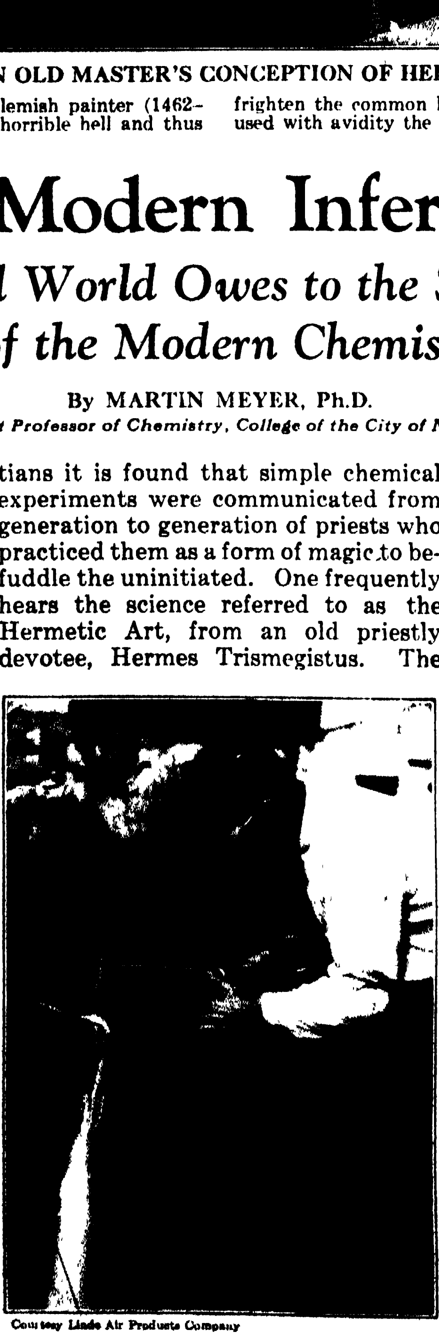
By MARTIN MEYER, Ph.D.
Assistant Professor of Chemistry, College of the City of New York

CHEMISTRY is a branch of knowledge especially wrapped in the cloak of mystery which that non-existent individual, the average man, is inclined to throw about any matter which he considers difficult or' profound. Until recently very little has been popularly known about it. Despite the dramatic horrors of the World War and later widely advertised discoveries of tremendous business importance, the word "chemist" still evokes mental images of the owner of the corner drug store.

Although the realm of chemistry is one of the most fascinating and absorbing fields of human thought, one can as a rule obtain little general attention to it. It has had, so to speak, no "sex appeal."

IT still remains for some one to do for it what H. G. Wells has done for history and Will Durant for philosophy. It shares with astronomy the honor of being the oldest branch of man's knowledge of nature and none has had a greater influence upon the course of civilization. The history of the human race is more truly reflected in the story of the progress of science than in the narrative of political biographies and names and dates of military conflicts that has long held the name.

In the records of the earliest Egyptians it is found that simple chemical experiments were communicated from generation to generation of priests who practiced them as a form of magic to befuddle the uninitiated. One frequently hears the science referred to as the Hermetic Art, from an old priestly devotee, Hermes Trismegistus. The Greeks had systems of natural philosophy which included chemistry and these, too, have transmitted their cultural influence to our own time. The commonly used phrase "exposed to the mercy of the elements" refers to an early conception of the chemical elements. The problem of the nature of matter is still a fundamental one.



Courtesy Linde Air Products Company

6300 DEGREES HOT

The oxy-acetylene flame cuts through solid metal like a warm knife through butter. What would early science have thought of it?

A belief of the same period was that all matter is composed of four primal things, or elements: earth, air, fire, and water. Aristotle was struck by the inadequacy of such a conception to explain the existence of the varieties of matter which he saw about him. He invented a fifth element, the "quinta essentia," the sublimated essence of everything, to account for the very apparent discrepancies. It survives in the word "quintessence."

ONE might be inclined to think that it hardly required a monumental intellect to decide that a silver coin was not made of earth and fire even though they were employed in its manufacture; but the ancients and especially the Greeks were lacking in the methodical experimentation which is the cornerstone of modern science.

Most of the knowledge of the ancients was acquired more or less by accident. If it had practical value it was practiced as an art by rule-of-thumb methods. Nevertheless they were remarkably efficient in many things which are today regarded as highly technical operations—the manufacture of glass and porcelain articles, the metallurgical processes and the fabrication of swords and implements with cutting edges. Some things which they knew have become lost arts and have not yet been rediscovered. It is highly doubtful that the modern "mortician" could embalm a body so that it would remain in the truly remarkable state of preservation for thousands of years exhibited by the mummies in museums.

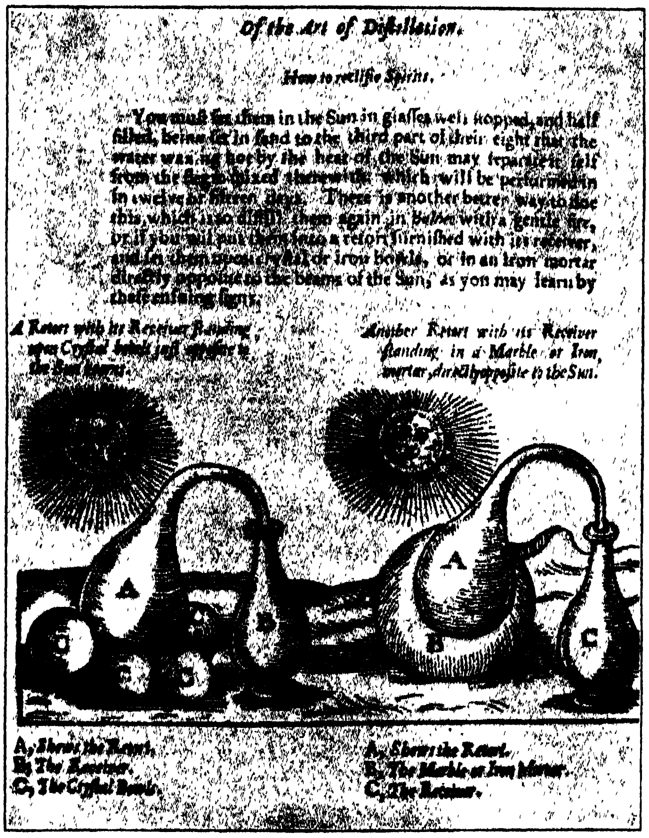
We could, if space permitted, trace the story of the science of chemistry among the Romans, the Arabs, the Chinese, and during the Middle Ages, and point out fascinating little bypaths for reading — such widely unrelated things as that the caliph Al Mansur, of Arabian Nights fame, was a patron of the alchemists, the medieval ancestors of the modern chemists, and that the romantically mysterious cult, the Rosicrucians, had vaguely chemical aspirations. Incidentally, the private lives of a few of the chemists would rival the pages of the daily tabloids for human interest.

IT is the modern science of chemistry which is the greatest miracle and its story begins about 1770 with the great French chemist, Lavoisier. It begins to differ from its ancient forbears by the introduction of the so-called "scientific method." This is a system of logical thinking, characteristic of all modern sciences, the result of a slow process of growth during a relatively short time, the last 200 years. Like many another thing it is a matter which, from the everyday viewpoint, is more clearly and easily illustrated than defined. It consists chiefly in the careful observation, classification, and explanation of the facts of nature, with laboratory experiment under regulated conditions. Largely by the genius of Lavoisier was such systematic method introduced into chemistry, and the French people showed their appreciation of his work by sending him to the guillotine during the Revolution.

But there were many at the same time and later to carry on his work, men whose names have become household words in the science—Scheele, Priestley, and Berthollet who made fundamental observations, Dalton who formulated the basis of the modern atomic theory, probably in its present form one of the noblest and most daring bits of speculation ever developed by man. Then, too, there was Faraday who studied the nature of electricity, which has since progressed to where the following old joke has lost its point: A professor of chemistry was lecturing on electricity to his class and happened to notice a student in a rear bench who was apparently fast asleep. He waited for a few moments to make certain of his observation, in the true spirit of science, and then addressed the impolite undergraduate very sharply:

"Mr. A., what is electricity?"

Jolted suddenly into consciousness, A. rose slowly to his feet and, mustering all the resources of a college education to a situation which was probably not unusual, answered the unheard question with a stammering:


Of the Art of Distillation.
How to rectifie Spirits.
Another Retort with its Receiver standing in a Marble or Iron mortar, directly opposite to the Sun.
A
B
C
A
B
C

EARLY LABORATORY METHODS

An early method of heating laboratory apparatus, from "A Compleat Course of Chymistry," by G. Wilson, London, 1709

"Er . . . I knew this morning, but I have forgotten."

"What a pity," replied the professor, "the only man in the world who knew what electricity is and now he has forgotten."

The modern chemist and scientist can tell, however, what electricity is with a degree of confidence. Electricity is matter. Matter is also electricity. The two are reduced to one, although we do not know which one it is, and that too is an interesting story.

Then there were Davy, Berzelius, Liebig the father of agricultural chemistry, Dumas, Kékulé, Mendelejeff, Ostwald, Perkin, the Curies, and a host of others who laid the foundations of the many branches of modern chemistry.

Within the last 30 years chemical knowledge has grown like a snowball rolling downhill, until the chemist's laboratory is the land of marvels. One of the foremost reasons for this has been the increase in the methods by which the scientist is able to control the conditions of his environment. Examples are too numerous to give in detail, so let us choose merely one as an illustration—temperature.

High and low temperatures enable us to produce many things that are not to be found in the heavens above, the earth beneath or the waters that are under the earth. About us we find a relatively narrow range of variation. In the habitable portions of the earth's surface the thermometer rarely goes below −40 degrees in winter and above 115 degrees in the summer. For centuries the temperature of ice, 32 degrees, and that of an open fire, about 1600 degrees, remained the greatest variation that man could produce for himself.

YOU recall the poet Dante's immortal story of his visit to Hell, and of the souls of the historically famous and infamous damned who were being tortured there by exposure to the torments of the extremes of ice and fire. The grandeur of the poetry will probably never be surpassed. But the modern scientist's only comment upon the scene it pictures is upon the poverty of the omniscient imagination which would employ such altogether ordinary temperatures to produce the desired effects. The scientist has liquefied air by cooling and compressing it and allowing it to expand repeatedly. The product is a pale blue liquid which resembles water from a distance but has a temperature of −310 degrees. In comparison, a cake of ice is literally red hot. By a similar process applied to helium he has produced a temperature below −458 degrees or less than 1 degree above absolute zero, the lowest temperature which can possibly be attained.

On the other hand, going up the scale, he can burn a mixture of ordinary illuminating gas and air in a blast lamp and obtain a temperature of 2700 degrees; with an oxy-hydrogen torch, 3600 degrees; and with an oxy-acetylene flame, 6300 degrees. The latter will cut through a quarter-inch steel plate with about the same ease that a hot knife goes through a cake of butter. Then in the electric arc he can produce temperatures which are limited only by the resistance of the furnace itself as it melts and breaks the circuit, the highest temperature so far being about 9000 degrees or more than half the estimated temperature of the sun.

Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed and equipped with up-to-date heating and cooling devices by the scientist, and compare it with the feeble attempt of the theologist. For the scientist, of course, these are merely the tools with which he works, but with them and others he achieves the wonders which distinguish the present world from any which precede it.

The extent to which this age is indebted to the chemist and the science of chemistry is boundless. There is no phase of man's activity which has not been profoundly influenced. In an age of machines and tremendous engineering attainments he supplies the materials—iron, steel, concrete—of which they are made in an endless stream, improves old ones, devises new ones to take their places, and makes processes of manufacture ever cheaper and cheaper.

IF the true test of human greatness is, as has been said, that of making two food plants grow where there was only one before, then here, too, the chemist has a just claim. By study of the soil and the growth of plants he has been able to double and triple the productivity of a given piece of land. With the help of the engineer he has been able to make the desert blossom as the rose, and render altogether unproductive areas fertile. He has delayed to a much later date Malthus' mournful prediction that within a comparatively short time the increase in the population of the earth will starve the human race to death. By scientific methods a very small portion of the United States could today feed the entire world.

In politics, too, the chemist quietly plays a prominent part. Histories of Europe of older days recorded the interplay of political forces as an attempt to maintain very delicate balances of power. Today a much more important matter is that of maintaining a balance of steel production, and one can better understand the desires of nations for disputed bits of territory if he consults a map of the location of iron ore and coal deposits than by consideration of vague feelings of racial fraternity. Military power itself is maintained more by high explosives, poison gas and flame, and the materials for producing and employing them than by the mere number of available soldiers. These are all essentially chemical problems.

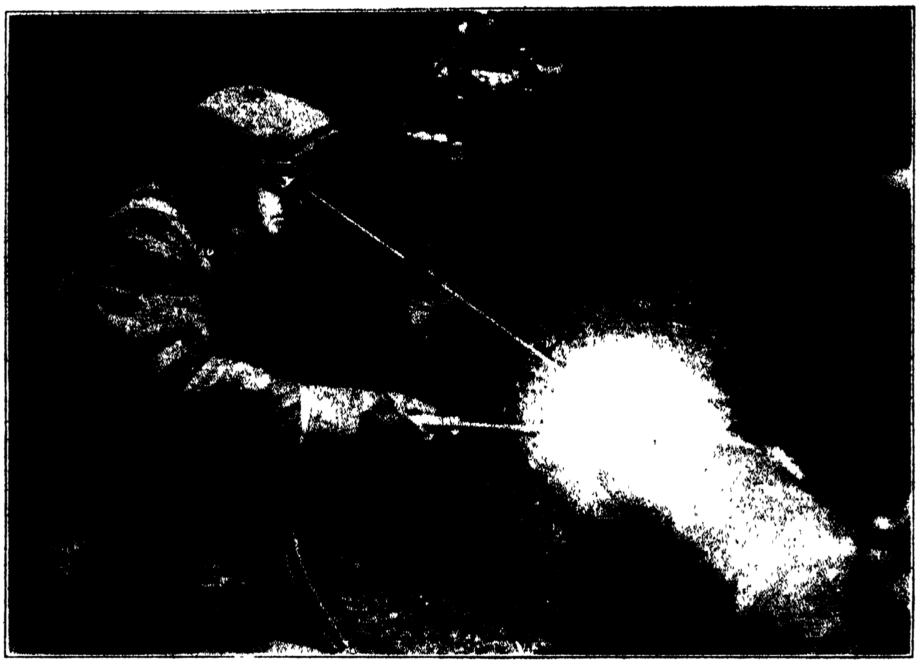
Sociology seems to be as far away from the activities of the chemist as anything reasonably could be. Even here one of the pressing questions of the day is the solution of the drug and narcotic difficulty. It has been said, and many believe, that the synthesis of morphine recently reported will solve it, and one can be hopeful when he considers the achievements of the past.

America's great contribution to civilization has been a democracy that works. Here chemistry plays a major role. Chemistry is the great agent of democracy. You can declare men equal by legislation but that which really makes them equal in their own eyes is equal opportunity to satisfy their desires. Although closely related, men value the ability to enjoy the luxuries of life above mere cold equality before the law. Chemistry has placed the luxuries of life within everyone's reach. There was a time when a certain purple dye was so expensive that it could be purchased only by the very rich, and the wearing of the purple was synonymous with wealth or noble birth. The chemist has analyzed Tyrian purple and made it so cheaply that all may have it, then discarded it for others of greater beauty and more lasting value. So has it been with precious stones as the ruby and sapphire, and with the more beautiful of the textiles such as silk.

At present we are writing another interesting and important chapter in the story of chemistry—Chemistry in America. Many are the marvels of applied science but these are based upon the discovery of the principles of science itself—pure science as it is called. This in turn rests upon the abilities of men who in the quiet and isolation of their laboratories devote years to the researches which will never be rewarded by the plaudits of the crowd or the luxuries of riches. Rarely does the pure scientist also discover the practical application for which these are the compensation.

Yet it is upon the labors of these men that the progress of science depends. This is a matter to which it would be well to devote serious thought. A famous educator recently deplored the loss of able scientists from the universities and colleges to industry which can pay better salaries. The fact is true, but one is inclined to doubt the reason. If human experience proves anything, rarely have the feet of genius been led from the path of loyal devotion by poverty or physical suffering. Again, in many branches of science such work today is more highly paid than similar work in industy.

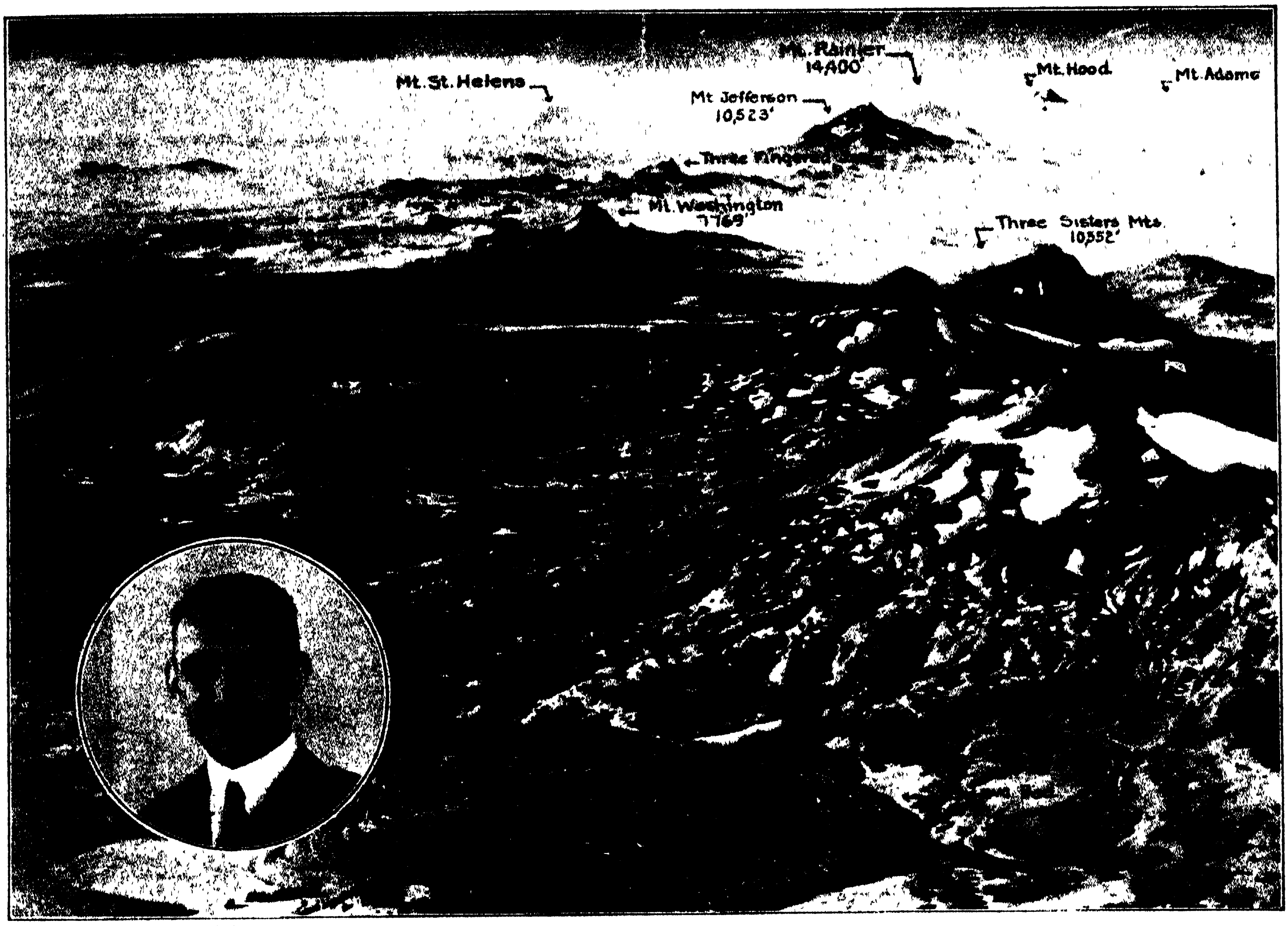
The statement may be interpreted as a serious criticism of the home of pure science itself—the colleges and universities. Often the positions of rank and eminence in their departments are held by men not at all distinguished by achievement, intellect or culture, but rather by the possession of that qualification so aptly described by Cabell as a much surer means of advancement. As a result, to the delicate sensibilities which always mark the man of intellect the situation frequently means intellectual suicide. He goes into industry because, whatever may be the unquestioned faults of the dollar as a standard of value, it has at least the advantages that it is impersonal and objective, two attributes imperative in the scientist.



Courtesy Linde Air Products Company

TEMPERATURES EARLY CHEMISTS NEVER DREAMED OF

"Picture for yourselves the sublime heights of torture which could be attained in an inferno properly designed by the scientist, and compare it with the feeble attempt of the theologist"



Illustrations courtesy Eastman Kodak Company

AERIAL PHOTOGRAPH SHOWING PEAK 227 MILES FROM THE CAMERA. INSERT: CAPTAIN STEVENS

Army Flier Secures Record Photograph

USING a special camera equipped with film sensitized to the infrared rays that penetrate smoke and haze, Captain A. W. Stevens, of the Army Air Corps, recently photographed Mount Rainier, in the state of Washington, from a point 227 miles away. Flying at an altitude of nearly 17,000 feet above a landmark that could be identified on a map, Captain Stevens pointed his camera in the direction of Mount Ranier and took his pictures despite the fact that he could not see his objective. When the photographic negative showed that Mount Ranier had been recorded, the distance was measured on a map from the mountain to the landmark over which the record-breaking picture had been taken.

Captain Stevens is head of the photographic branch of the Air Corps stationed at Wright Field, Dayton, Ohio. His pilot was Lieutenant John Corkille, also of Wright Field. Last winter the same fliers made a picture from an altitude of 37,854 feet, higher than a camera had ever been used before, using the same type of equipment. The War Department authorized the flights because of the valuable contributions to military photography that are expected to result from Captain Stevens' experience.

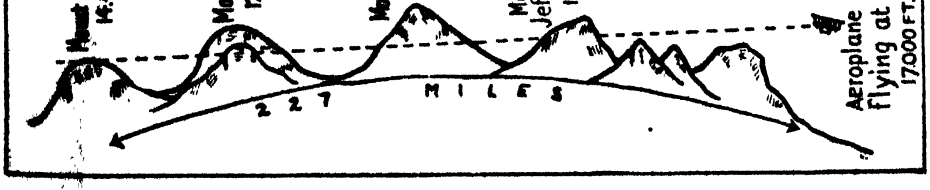
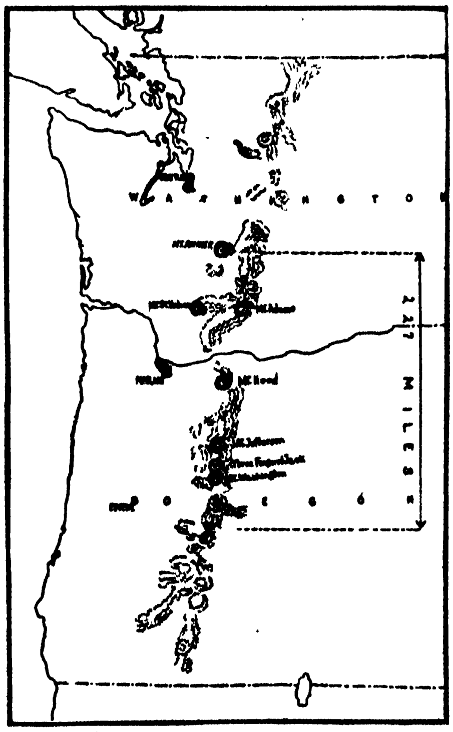

Mount Rainier 14,400 FEET
Mount Adams 12,300 FT.
Mount Hood 11,225 FT.
Mount Jefferson 10,525 FT.
Aeroplane flying at 17,000 FT.
2 2 7 MILES

DIAGRAM SHOWING CURVATURE OF THE EARTH

Although Mount Ranier has an altitude of 14,400 feet, it seems to be lower than Mount Jefferson, which has a height of 10,525 feet. This is due to the curvature of the earth



TOO FAR TO SEE

Although the mountain was invisible, it was recorded on the sensitized film

Painting With Light in Barcelona

Spectacular Electrical Lighting Effects Enliven the Spanish International Exposition

THE Barcelona International Exposition, located near the outskirts of the city on the slopes of the mountain of Montjuick, occupies nearly a square mile. Taking advantage of the exceptional natural position of this mountain side, the planning architect, Don Carlos Buigas, worked out a system of illumination which surpasses all that has been done heretofore in exposition lighting.

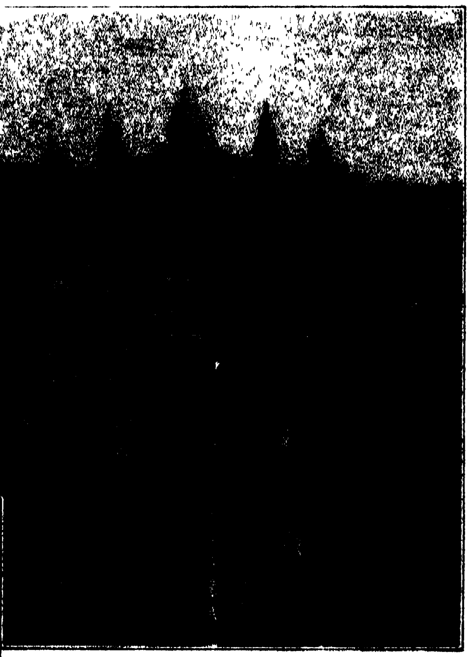
The idea dominating the entire project is the absolute suppression of direct lighting. Illumination is obtained in all cases by indirect means, either by concealing the lamps and reflectors in corners, or in decorative "motifs" of the buildings' piazzas and façades. By mounting lights within luminous crystal elements of attractive design, fantastic imitations of flowers or plants are obtained.

In addition to the light obtained by such methods, additional illumination is produced by colored lights submerged in the innumberable fountains and cascades located within the decorative area.

As in other electrically illuminated fountains in America and abroad, the lighting effects are made to vary in intensity and color to suit the fancy of the operator.

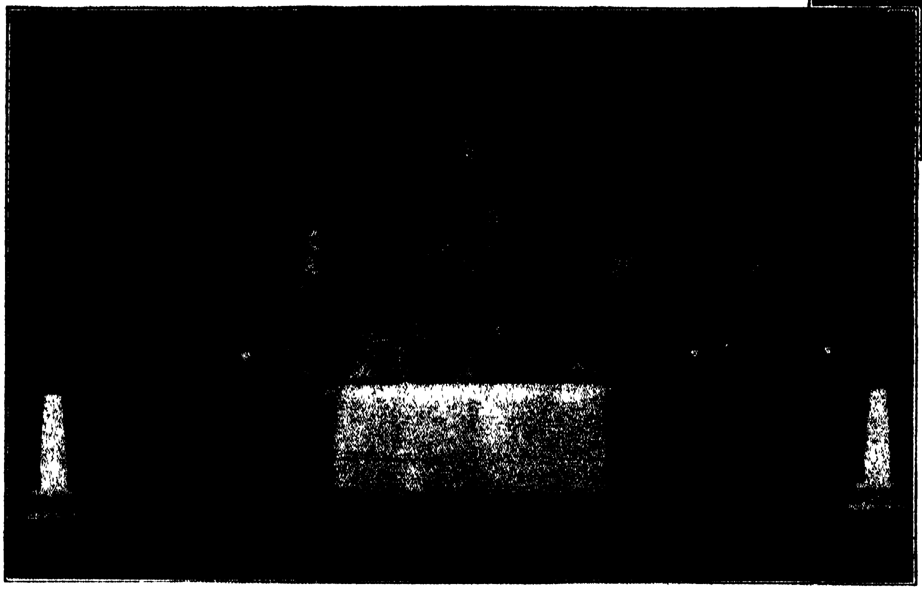
Control of all illumination at the exposition is centered in a tower at the main entrance. This arrangement was adopted in order to make it possible for a lighting expert to look out over the entire decorative area and "paint" the exposition grounds with any color effect he might desire. The controls are operated from a switchboard of special design.

One of the most effective displays is a mobile lighting program, automatically controlled, which consists of waves of colored light, flowing in rythmic succession over the entire exposition grounds. For example, a white wave appears at the National Palace, progressing slowly through the various cascades and fountains toward the Plaza de Espana. As the white wave reaches Reina Maria Cristina Avenue, a yellow wave leaves the National Palace and follows the path of the first, at the same rate of speed. The wave of yellow light is succeeded by one of red, and finally by another of blue. The waves progress at the rate of less than ten feet per second,



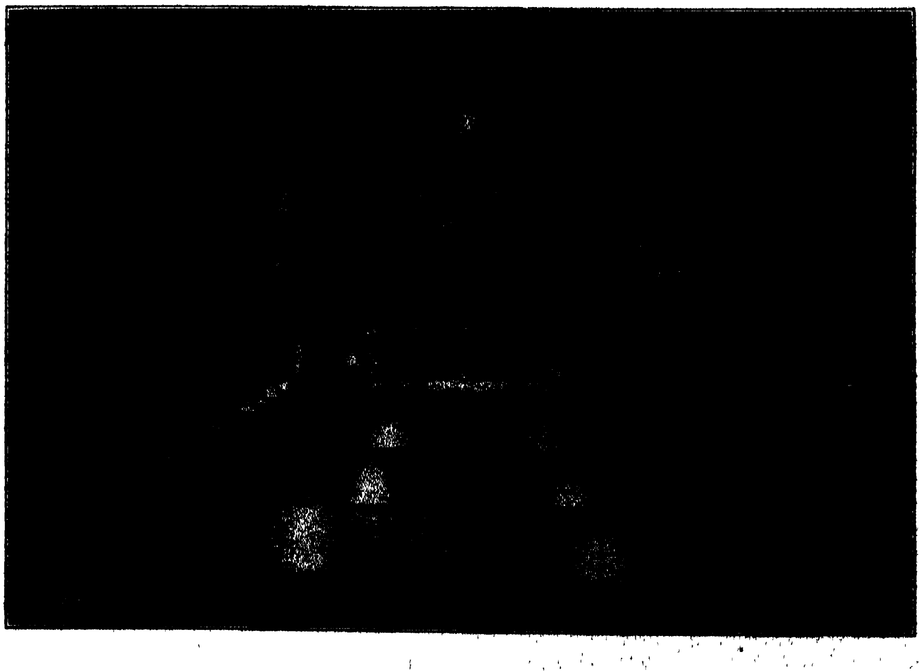
THE EXPOSITION GROUNDS

Looking up the principal avenue toward the Palace, art center of the exposition



ABLAZE WITH COLORED LIGHT

Fountains and cascades in ever-changing colors dominate the decorative display



THE "NATIONAL PALACE"

The Palace against a black background with an aurora of colored light beams and the entire program lasts about ten minutes.

The total electricity required in the decorative area for illumination and lighting effects is about 5232 kilowatts. It would have been almost impossible to regulate this current by direct means, since it would have been necessary to use cable of inadmissible size, and control apparatus of undesirable dimensions. By means of a system worked out by lighting engineers of the Westinghouse Electric and Manufacturing Company, the entire illumination system is powered and controlled by comparatively simple means.

The plan utilized in this system provides indirect control by means of pilot lines of extremely small diameter. This is made possible by using special three-coil reactors, wound on iron cores. The two outside coils are connected in series for carrying the load current, and the middle coil is connected in a direct-current circuit regulated from the control station in the tower.

REVEALING THE SECRET OF THE ILLUMINATED CASCADES

Construction photograph showing the operating units of one of the cascades; when in operation these spray and lighting units are submerged beneath several inches of water

When no current flows in this direct-current coil, the two alternating-current coils possess a high reactance in series with the light. The whole is so calculated that, when there are enough lights in circuit to correspond with the full load of the reactors, the lights are practically extinguished. Upon passing current through the direct-current coil, the flux in the core of the transformer will increase, and upon reaching saturation point, the outer coils will have practically no effect and the lights will have their full brilliance. Between these two extremes, any intermediate degree of brilliance may be obtained.

"FLASHER" CONTROLLING WAVES OF COLORED LIGHT

This automatic control unit regulates the movement of successive waves of colored light, which start at the National Palace and progress slowly over the entire decorative area

By this means, since the current absorbed by the direct-current coil is very small, it is possible to control a large amount of power with a small rheostat and very fine wires. The reactors used in these controls are the largest ever built, varying in size from 16 kilowatts, 125 volts to 200 kilowatts, 6000 volts. All of the reactors are oil-insulated. A total of 200,000 cubic meters of water is used each day in the fountains and cascades. Powerful electric pumps are used to circulate the water.

The largest of the fountains plays a stream 200 feet into the air, and the smaller sprays and streams surrounding the main stream are so arranged that it is possible to change the effects into 32 different shapes.

AUTOMATIC DIMMER BANKS

View of the individual electric motor-driven dimmer banks used in the mobile lighting program, regulated by the flasher illustrated above; the waves of light move at the rate of ten feet per second

SWITCHBOARD FOR LIGHTING EFFECTS

American engineers designed this special switchboard, by means of which a lighting expert can "paint" the entire decorative area of the exposition grounds with any effects he may desir

The Winning Design in Our Light-Plane Contest

A Detailed Description of the Tandem Biplane With Steel Fuselage That Won the Scientific American Medal

American Airmindedness Proved

SO often is the aphorism repeated "Americans are gradually becoming air-minded," that we are entitled to scan the facts for proof.

A recent questionnaire sent to our subscribers in a geographical cross-section of the United States, shows that 75 percent were alive to the importance of the developments in aviation and 24 percent actively use this service, while 27 percent are potential airplane owners.

In the SCIENTIFIC AMERICAN competition for the best light airplane designs, 80 individuals were interested enough to write in for specifications and 19 complete designs were finally submitted in the contest. Considering the amount of work necessary to draw up detailed calculations, draft the three views and extend the tabulation of specifications for the particular design, it will be evident at once that widespread and sincere interest in the art has been demonstrated in places and among persons who hitherto had not revealed themselves to general public cognizance. Also, there is a decided interest shown in articles on aviation, particularly from the investment standpoint. Like all developments that have an appeal to the heroic or mystical element in us all, investment in aviation has probably attracted more people than is realized, for surely the flotation of aviation stock has gone on apace; in fact the industry itself has outsped the preparation of a market for the output.—*The Editor.*

THE SCIENTIFIC AMERICAN announced in the March, 1929, issue a light-plane contest and through the generosity of Colonel R. Potter Campbell, President of American Cirrus Engines, Inc., it offered a prize of 500 dollars and gold medal, a silver medal, and a bronze medal for the best three designs of a light two-seater airplane.

The object of the contest was to interest the public in the possibilities of a comparatively undeveloped field in aeronautical design, as we believe a light two-seater for training, sports use, and private ownership built to sell for a reasonable price without sacrificing aerodynamic efficiency, is the type needed to give additional impetus in this new industry.

The country with its ever growing airports, its unlimited resources, and its large market should lead the world in the light-airplane field.

The contest rules called for a plane to be designed about the Cirrus Mark III engine, an air-cooled, 4-cylinder motor designed by Maj. Frank B. Halford, principally for use in the De Haviland Moth, a low-powered two-place biplane. It has also been installed in the Avro Avian, the Great Lakes Trainer, and many other light planes and in the last few years has established an enviable record. This engine has been supplied to all the light-airplane clubs subsidized by the British Ministry. It also holds such records as Lady Heath's famous flight from London to Cape Town, a flight from England to India, the light-airplane altitude record, the light-plane non-stop record, and the distance record for a pilot unaccompanied. So it was selected as the one around which the design for this contest should be drawn.

THE rules of competition were, essentially:

1. The design was to be one for a plane which would be most suitable either as a training plane or as a sport plane for private ownership.
2. Minimum equipment allowed by the Department of Commerce in the way of instruments was required.
3. The fuel system had to provide for five hours at full throttle.
4. Provision for 50 pounds of baggage and a baggage compartment.
5. Minimum gliding speed of 40 miles per hour. Maximum speed to exceed 95 miles per hour.
6. No restrictions were placed on the type of design. The fuselage was to be of metal construction, but the wings could have been of wood construction.
7. Each competitor for the prize was required to submit the following information:
   - (a) Three views of plane and main dimensions and characteristics.
   - (b) Detailed weight estimate.
   - (c) Balance diagram and stability and control considerations.
   - (d) Preliminary performance calculations.
   - (e) Preliminary stress analysis.
   - (f) Drawing showing power-plant installation with gasoline system.
   - (g) Drawing showing accommodations for pilot and passenger.
   - (h) Sketches or preferably drawings illustrating the structure of the plane, wings, fuselage, tail surfaces, landing gear, and controls.
8. The designs were rated according to:

(a) General suitability of the plane for training and private ownership purposes and general excellency of the design	20 points
(b) Performance	15 points
(c) Power plant installation	15 points
(d) Construction and ease of maintenance	80 points
Total	130 points

The judges of the competition were:

Miss Amelia Earhart—representing woman's accomplishment in aviation.

Mr. George Palmer Putnam—private plane owner.

Professor Alexander Klemin of the Daniel Guggenheim School of Aeronautics, New York University.

It can be seen from the point rating that the plane's construction and adaptability to quantity production were of the utmost importance.

A large number of designs were submitted by students, draughtsmen, and salesmen and were received from every part of the United States and England.

The plans submitted showed almost every type of wind and fuselage arrangement: biplanes, high, mid- and low-wing monoplanes, and even a helicopter.

The judges found the designs excellent as a whole and after much deliberation chose the design by Mr. Rigby for the prize. [See page 45, January 1930 issue. Editor.] He was awarded 120 out of the possible 130 points. Mr. Rigby's plane is a tandem biplane with a steel fuselage and wooden wings.

The fuselage is of low-carbon steel (1025) using the full Warren truss and welded joints. The two cockpits are located out beyond the wing, giving good visibility and accessibility.

The gasoline tanks and the baggage compartment are located forward of the cockpits near the center of gravity. Thus the designer provided a small movement of the center of gravity under all possible loading conditions.

The wings are of the conventional wood and fabric type with built-up box spars, pinjointed at the fuselage. Ailerons are used only on the upper wing.

The landing gear is of the split-axle type using disk shock-absorbers and the tail skid using rubber cord.

The tail surfaces are of dural, having an adjustable stabilizer and fin. The rudder is balanced and all surface controls are of the cable type.

The performance for the winning ship follows:

Landing speed	39 m.p h.
High Speed	95 m.p.h.
Climb	693 ft. per min.
Service ceiling	14,500 ft.
Absolute ceiling	16,500 ft.
Endurance	5 hours

The structural specifications:

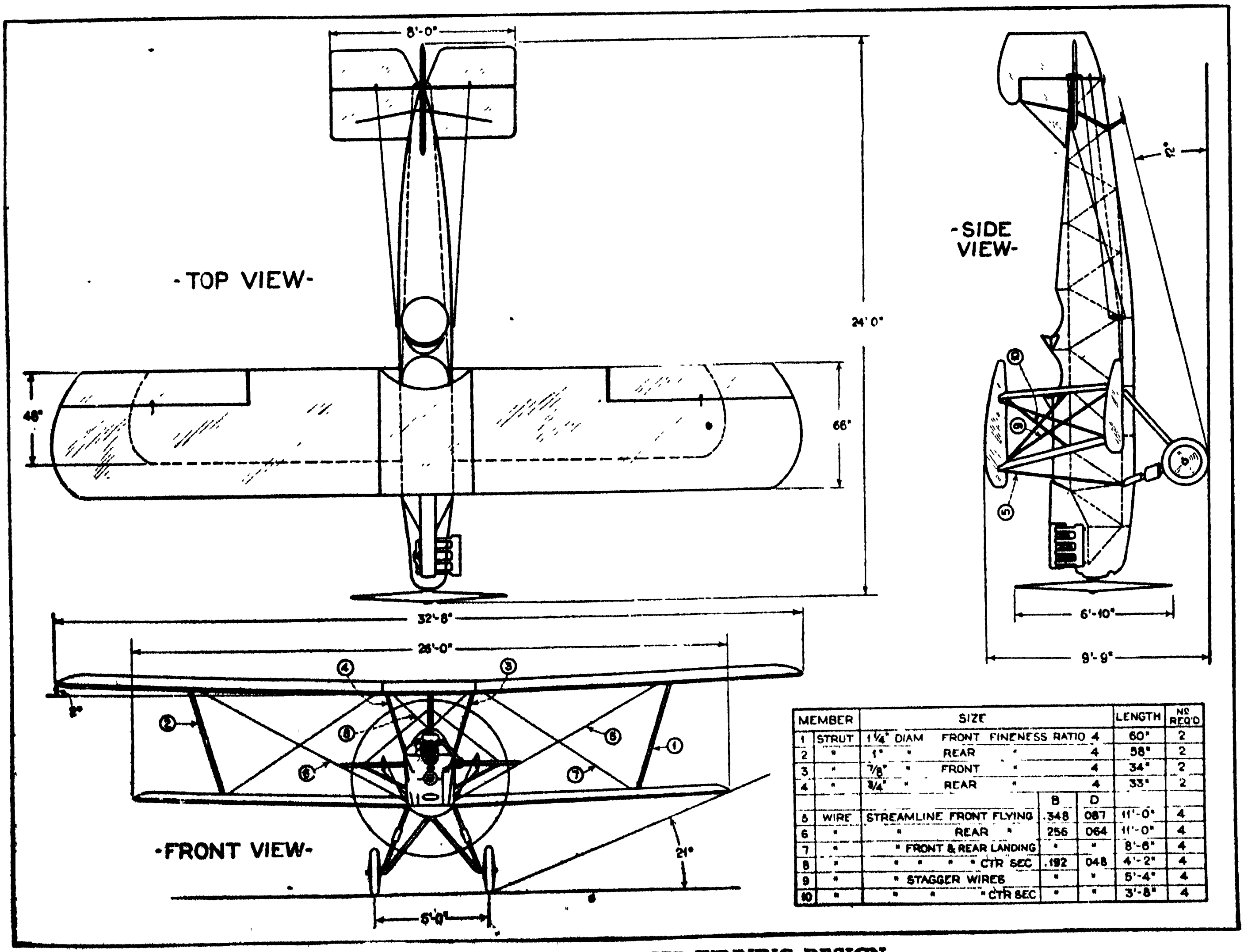
Type	Biplane
Span, upper	32.8′
" lower	26′
Chord, upper	66″
" lower	48″
Height	9′9″
Length	24′
Stagger	18″
Gap	60″
Incidence	0°
Dihedral	2°
Area, upper wing	165 sq. ft.
" lower wing	88 sq. ft.
" total	253 sq. ft.
Aileron area (upper)	24 sq. ft.
Area, stabilizer	16 sq. ft.
" elevator	12 sq. ft.
" fin	4 sq. ft.
" rudder	8 sq. ft.

Airfoil U. S. A. 27

Mr. Huep was awarded the silver medal for his design of a low-wing, full cantilever monoplane with tandem seating accommodations. The unique feature of this design was the convertibility from an open cockpit to a cabin model with a slight increase in weight.

Mr. Beebe's design was awarded the bronze medal for a side-by-side, low-wing, semi-cantilever monoplane. The ailerons extending the whole length of the wing could be used as flaps or as differential ailerons.

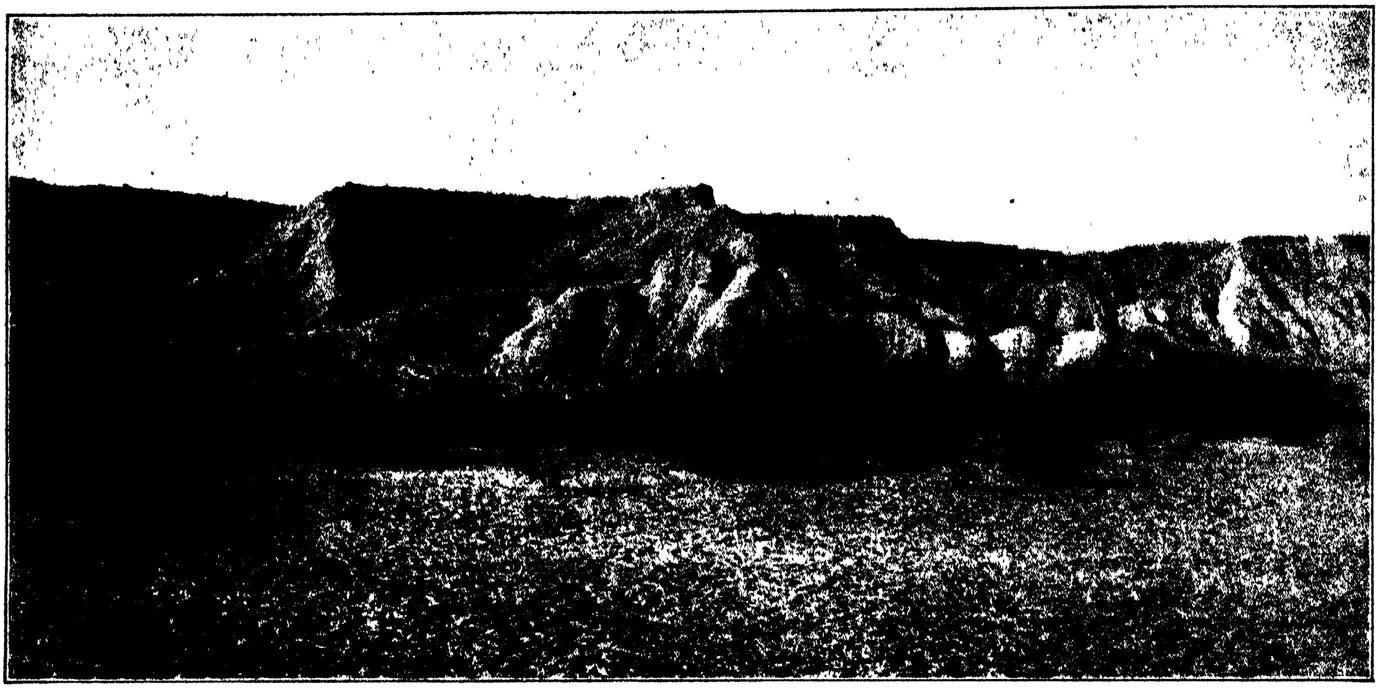
Viewed from all standpoints the contest is a decided success, as much interest has been aroused in the possibilities of the general development of the light airplane for use by persons of average airmindedness.



MEMBER		SIZE			LENGTH	Nº REQ'D
1	STRUT	1¼" DIAM FRONT FINENESS RATIO 4			60"	2
2	"	1" " REAR " 4			58"	2
3	"	⅞" " FRONT " 4			34"	2
4	"	¾" " REAR " 4			33"	2
			B	D		
5	WIRE	STREAMLINE FRONT FLYING	.348	087	11'-0"	4
6	"	" REAR "	256	064	11'-0"	4
7	"	" FRONT & REAR LANDING	"	"	8'-6"	4
8	"	" " " " CTR SEC	.192	048	4'-2"	4
9	"	" STAGGER WIRES	"	"	5'-4"	4
10	"	" " " CTR SEC	"	"	3'-8"	4

THREE VIEWS OF THE PRIZE-WINNING DESIGN

Out of a possible 130 points, this design was awarded 120, and so was proclaimed the winner. Note the clean appearance of the front view and that ailerons are used only on the top wing. Details of the performance of this ship are given in the center column directly above



MESA HOUSE RUIN FROM THE FLATS BELOW THE MESA OR TABLE LAND

The ruin lies just back of the central point of the picture. The elevation of the mesa above the bottom lands of the river valley, in the foreground, is 120 feet. The steep slope, up which the attacking tribes must fight, made the defense of the chosen position relatively easy

The Last Stand of the Nevada Pueblos

In Southern Nevada Another "Lost City" of the Early American Indian Has Been Discovered, Throwing Light on Pre-Columbian History

By IRWIN HAYDEN
Assistant Archeologist, Southwest Museum, Los Angeles

THAT the peace loving Pueblo Indians who occupied southern Nevada at the opening of the Christian Era, hard pressed by hungry nomads, were finally compelled to build fortified villages on inaccessible mesas, is the mute testimony of ruins recently uncovered by a party of field workers sent out by the Southwest Museum.

A handful of Mormons and a small band of southern Piutes have inherited what was, when Jesus was born, a veritable Garden of Eden to these Pueblos, who lived and prospered by thousands in the lower valley of the Moapa River. There they built their houses, often in such large groups that these have been called cities. There they planted maize, squash, beans, and cotton in the fertile and friable soil, irrigating their crops with the waters of the stream which meandered lazily over the bottom lands between the high and barren mesas which form the eastern and western rims of the valley.

For many centuries they had lived there; first, apparently, a rude people who made baskets and used the dart-thrower, not knowing the bow and arrow, ignorant of the art of making pottery; then a people who not only had learned to cultivate maize and beans but to make pottery and to substitute for the dart-thrower the bow; and finally a people who knew the art of building rectangular houses consisting of single rooms, with vertical walls and flat roofs, of mud and stones and mesquite poles and thatch of arrow bush and arrow cane.

THESE people lived richly. The land smiled upon them, yielding bountifully the foods they liked best to eat, the maize or Indian corn and its "little sisters," beans and squash, which in the long ago other Indians had domesticated in the high plateau country of middle America. Their cotton-fields supplied material for their well woven textiles. In the neighboring highlands mountain sheep were plentiful; wild fowl teemed in the ponds and marshes. Fuel and water were there; and so were numerous sources of flints and obsidian for arrow points and spear heads, knives and scrapers. Pure rock salt for flavoring food, for ceremonials and trade; clay for pottery; magnesite for the clean white slip with which they coated the inside of the food bowl, red paint stone for the red slip; Spanish bayonet and iron stone for the paint used for the black designs on the bowls; turquoise for ornaments—all of these things and more they had, these early Pueblos, there in the Moapa Valley.

In that valley, as related in the SCIENTIFIC AMERICAN for July 1925, M. R. Harrington, with the help of Mr. Fay Perkins and others, discovered and explored in part the famous "Lost City of Nevada."

The results of that work, done under the auspices of the Museum of the American Indian, Heye Foundation, brought to light the ruins of a large settlement which was at the peak of its development in the early centuries of the Christian era, at a time when in all of North America there probably was no place more thickly populated or more "prosperous," as we of today would say, than that section of southeastern Nevada.

It was the good fortune of the writer to have been assigned the task of excavating another "lost city of Nevada," across the Moapa River from the Lost City, and some eight miles north. The task was assigned by M. R. Harrington, who was in the field as leader of

the Nevada Expedition, 1929, sent out by the Southwest Museum of Los Angeles, of which Mr. Harrington is now Director of Research. The Southwest Museum concerns itself primarily with the problem of early man in the southwest area of North America; and the scientists who are directing its research feel confident that buried in the earth and the caves of southeastern Nevada are many secrets, the uncovering of which will help materially in telling the story of the beginnings and the development of the great Pueblo peoples whose brilliantly colored life and history make the territory which includes Arizona, New Mexico, much of Utah, Colorado, Texas, and Nevada, so fascinating to tourist and scientist alike.

MAPPING THE RUINS ON TOP OF THE MESA

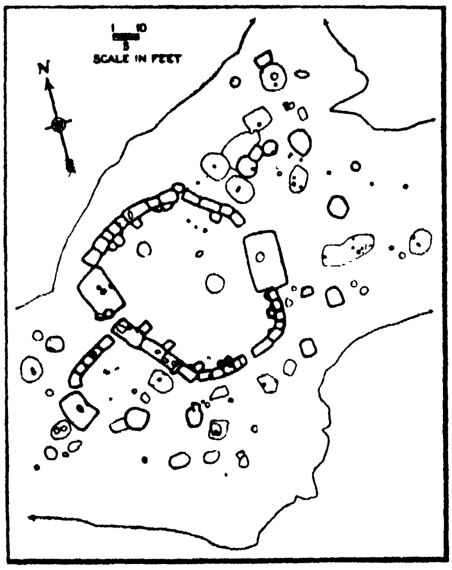
The surveyor is bending over a plane table at the right, his rodman stands at the left of the picture, and a tape, dimly visible in the picture, is stretched between the two points

THE writer, assisted by his son, Julian D. Hayden, and by James G. Scrugham, Jr., son of ex-Governor Scrugham of Nevada, whose great personal interest in archeology has done so much toward aiding the work of exploring the Nevada ruins, spent three months in the complete and thorough excavation of the Mesa House ruin, about three miles north and west of the Mormon town of Overton. Meanwhile Mr. Harrington roamed the lower reaches of the Moapa River, locating and platting the many evidences of Indian occupation, from Basketmaker pit dwellings to early Pueblo village sites and southern Piute camping places. The lower end of the Moapa Valley is expected eventually to be covered by the waters impounded by the great Boulder Dam, and much of the very important archeological evidence will become lost forever unless it is collected within the next few years.

One very striking thing was brought to light by the exploration of Mesa House, when the situation there is compared with that at Lost City. The mute evidence of stones and fallen 'dobe walls found at Mesa House is eloquent in its story of a people brought to bay by human enemies. The ruins of the Lost City speak as eloquently of a people who were at peace.

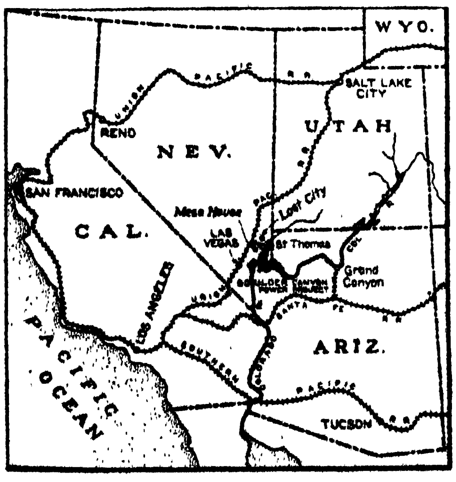
Evidence gathered at both places indicates clearly that Lost City and Mesa House were built and occupied by early Pueblos. Mesa House, however, represents the last stand of these people in the Moapa Valley, before they moved into Arizona (or possibly Utah). The tradition among the southern Piutes who were in the Moapa Valley when the first white men settled there is that the builders of the pueblos went to Arizona and became the ancestors of the present Hopi.

Whoever visits Lost City and Mesa House (it would be well to do so before Lost City becomes inaccessible because of Boulder Dam, as it may) will observe the fact that Lost City houses are grouped in a free and easy way, with no apparent plan. But the houses at Mesa House are built around a central courtyard, in the form of a circle roughly drawn; and there are but three narrow gateways to this courtyard. Here, then, was essentially a walled town. Outside the walls, not too far away, were dwellings, arbors, storage rooms; but at the first alarm all could run into the "fort" and make effective resistance to raiding Piutes, Apaches, or whoever the enemy might be.



MAP OF THE RUINS

The enclosed figures on the map correspond with the walls, like, for example, those in the illustration shown above



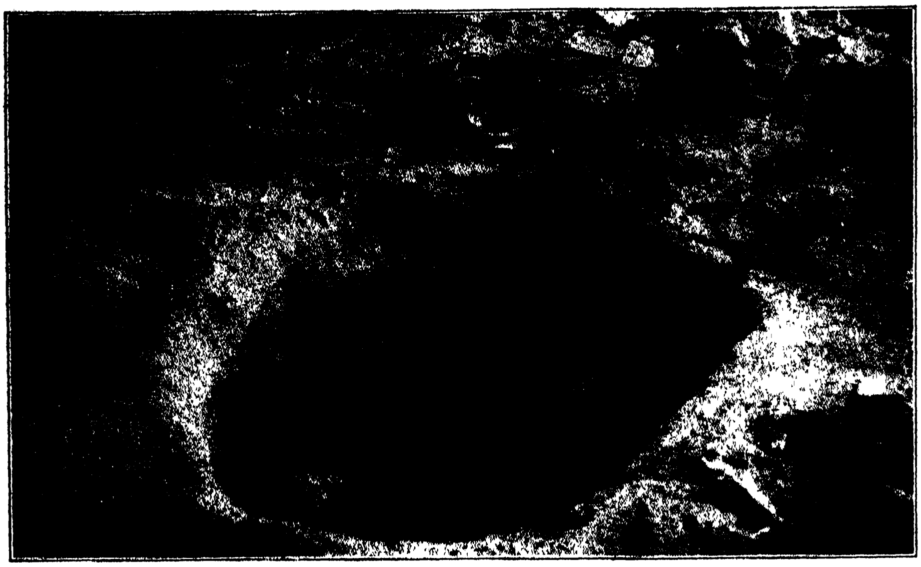
THE GENERAL LOCALITY

Both Mesa House and the Lost City are indicated at about the center of the map

Lost City was built on low-lying promontories, near fuel, water, and farms. Mesa House lay on top of a barren mesa or table land, swept by the bitter winds from the Mormon mountains to the north, standing 120 feet above the bottom lands, from which food, water, fuel, and most of the building material had to be carried up pathways rising about two feet in one, so steep are the sides of the mesa.

AS a place to live, Mesa House was decidedly inconvenient. As a place to defend, it was ideal. To the east lay the open valley; to the north a broad cove in the mesa; to the west open country for several miles, in spite of the rising hills; and to the south and close at hand a high place where lookouts could command the entire country side. Indeed, on the very top of this high place were found the remains of ancient watch fires.

In comparison with Lost City, Mesa House produced a much greater number of "wicked looking" arrowheads. But, also in contrast with Lost City and village sites of the Lost City period (for miles up and down both sides of the valley there are ruins of villages identical in pottery with the Lost City), the people of the Mesa House were poor in worldly goods, for the graves at Mesa House contained very meager offerings, while Lost



A LOST CITY BURIAL, WITH POTS AND PET DOG

At Mesa House, however, only one grave contained anything of importance. The potsherds, or pieces of broken pots, tell the trained prehistoric archeologist almost as much as actual inscriptions, for the styles in pottery undergo many changes, thus affording a time scale

City graves, many of them, were rich with pottery, weapons, ornaments and other objects.

In fact, only one grave at Mesa House contained anything of importance. Some thirteen turquoise pendants, 24 arrowheads, several dozen gaming pieces, a flint knife with handle intact, and two very fine war clubs carved from elk horn, were included in the grave of an adult, who must have been, in his lifetime, a leader among his people. This grave was in the center of a great room, apparently built of "wattle and daub"; which means that posts were set up, scantling run across the sides and ends, against which a thatch of arrow cane or tules was laid, and the whole plastered with mud, both sides and roof. The room had been destroyed by fire, perhaps immediately after the burial of the great man.

HARRINGTON insists that Mesa House marks the wind-up of the early Pueblo occupation of the Moapa Valley. That Mesa House is of a later period than Lost City is made clear by a study of the potsherds so numerous in all of these ruins. Fragments of broken pottery vessels, the "shards" so useful to Job in his affliction, the "potsherds" of the archeologist, can be made to tell a great deal about the comparative age of different Indian villages and camp sites, provided always that they are found.

The potters of the Lost City period catered to fashion, just as our modern potters do; just as potters always have done and always will. The Lost City housewife demanded and made pottery which chiefly was either plain or decorated with black lines on a white or a red background. Occasionally some good housewife, as she coiled the rolls of clay 'round and 'round in the building of the pot or bowl, omitted the usual smoothing of the outside, leaving ridges or corrugations for ornamental effect. These corrugations were left straight or were indented or notched, according to the taste of the potter. Lost City potters only occasionally made this corrugated pottery.

Now at Mesa House two thirds or more of all the fragments of pottery found is corrugated. Ordinary plain pottery, or undecorated ware, is noticeably rare; and dishes bearing black designs on white background, the typical black-on-white of the early Pueblo period in the southwest, is infrequently found, while the black-on-red dishes are very rare indeed.

The relatively greater use of corrugated ware at Mesa House, as compared with Lost City villages, does not of itself indicate anything about the comparative dates of the two periods, Mesa House and Lost City.

It happened, however, that on another village site, which plainly was occupied by early Pueblos, the writer unearthed what seems to be a key to the situation. This ruined village stood on a tongue of the same mesa on which the Mesa House was built, and not more than 1500 feet from it. It was discovered by Mrs. Harrington on one of her scouting trips. There, in a layer of accumulated ashes and rubbish more than three feet deep, in spots where everything pointed to a long occupation, all of the broken pottery was of Lost City type, plain, with some black-on-white and black-on-red ware; except that in the uppermost six inches, and on the surface, fragments of corrugated ware appeared.

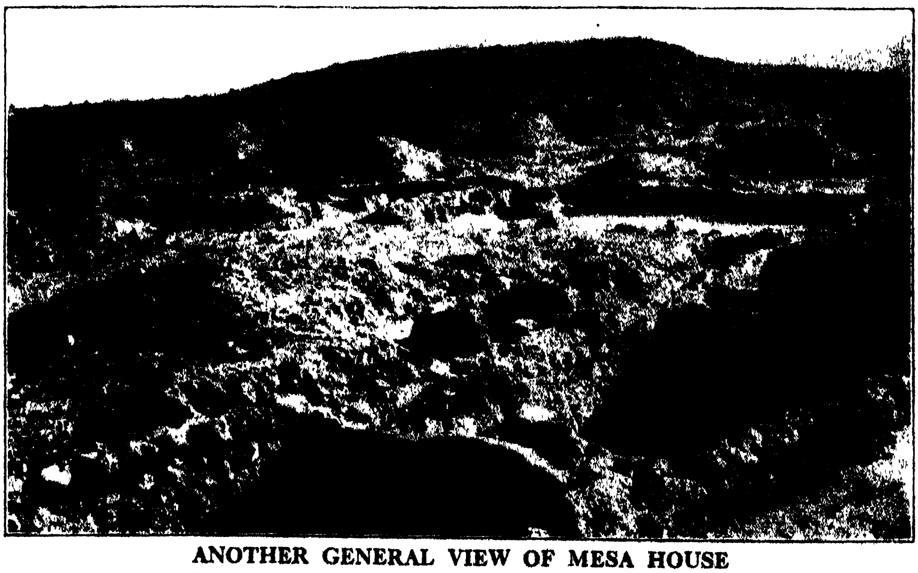
Lacking evidence to the contrary, then, Mesa House is dated later than the villages of the Lost City period.

Using the tentative time scale suggested by Dr. Alfred V. Kidder, Mesa House was abandoned sometime between 500 and 800 A.D.

PERHAPS thousands of years were covered by the development of these peoples in the Moapa Valley. But when did any sedentary, agricultural people, who insisted on peace as a prime requisite to happiness, ever succeed in enduring the constant irritation of raids from destitute, hungry nomads?

Apparently the early Pueblo fought only for defensive purposes. It is evident that his posterity, the present Pueblos, made no offensive wars. Dear to them as the Moapa Valley must have been, it was not sufficiently dear, apparently, to justify their fighting to hold it.

So, if we read the record rightly, they left it to the southern Piutes, who gave it over to a colony of Mormons which Brigham Young sent there to raise cotton.



ANOTHER GENERAL VIEW OF MESA HOUSE

This shows clearly the type of masonry wall construction employed by the former builders and occupants of the ancient community. The houses were drawn up around a roughly circular court yard, but without much planning, as is shown by the map on another page

Opera Comes Into Its Own

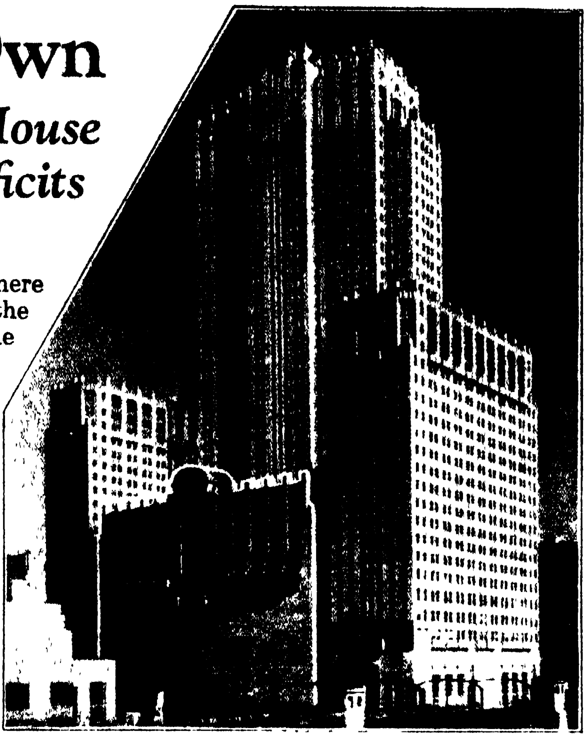
Combining Offices With an Opera House May Solve Problems of Perennial Deficits

By ALBERT A. HOPKINS

CHICAGO goes in for the grandiose and generally succeeds. She certainly has many things which can be classed as the "largest" and many as the best. This has largely been accomplished by a remarkable civic spirit which manifests itself in many non-commercial cultural enterprises of great magnitude. The World's Fair of 1893 gave Chicago a place in the sun, and she has worthily maintained it. It was a few years previous to this that Chicago built a real opera house, the Auditorium, with a modern stage with hydraulically operated bridges. But time makes all things obsolete, and so Chicago felt that her opera was so good that a new opera house was in order, and we shall tell some of the wonders of her 20,000,000-dollar structure which was opened recently with the unfortunate Aida's troubles.

The structure known as "20 North Wacker Drive" is 45 stories high with two 23-story wings. In this skyscraper are the Opera House and the Civic Theater accommodating 3517 and 878 persons respectively. The box-office has been separated from the main lobby so that persons with tickets do not have to mill around with would-be purchasers. The orchestra is so arranged that no late comer has to climb over more than four of his predecessors in order to reach his seat. The dress circle, the balcony, and the upper balcony have been brought forward over the orchestra so that the occupants of these seats are brought much nearer to the stage. There is no seat in the house where the whole stage is not in view. The last seat in the upper balcony is 185 feet from the stage. The chairs in the boxes are of two sizes, the taller ones for the men and the smaller for the ladies.

Every device which modern science has invented for the improvement of stagecraft and the speeding of scene changes demanded by modern opera is called into play. The technical director and stage director have at their command many devices which have never before been used on the stage of any theater in the entire world.

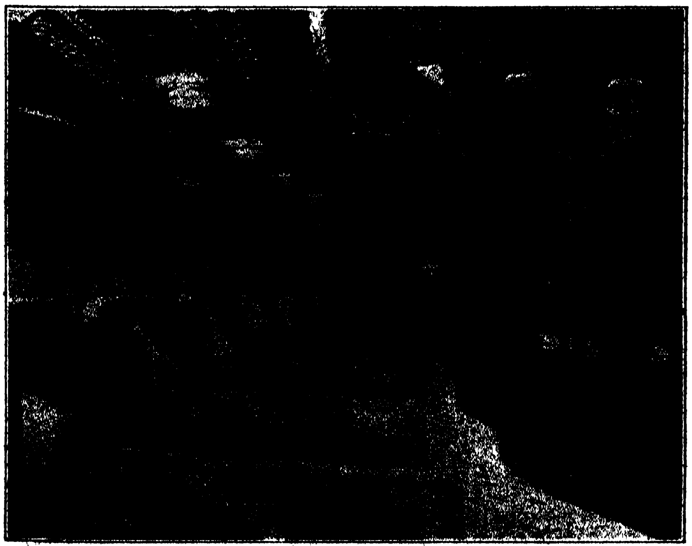


SEEN FROM THE RIVER

The new Chicago Opera House rises majestically 560 feet. The Opera House proper is outlined in white

THE stage itself, while not the largest in the world, being exceeded in breadth by one or two stages in Europe, is considerably larger than anything in the United States. It measures 75 feet in depth and 120 feet in width at its widest point. The important element of height which governs the size of drop curtains, cycloramas, trees and foliage, buildings, and so forth, in outdoor scenes, has received special attention.

The stage measures 145 feet from floor to gridiron. The working stage, 50 feet in width, is divided into 20 sections which lift or lower, each of them being 25 feet long by four feet wide, and with a lift of 12 feet and a drop of 12 feet. They can also be tilted to a maximum angle of 35 degrees in either direction. The 20 sections, or traps, are mounted on hydraulic rams. Forty plungers in all are used, two for each trap. All are operated from the main control station at the right-hand side of the stage. Each plunger is fitted with a clamp, holding it secure at any level, and insuring against movement in case of leakage in the hydraulic system. All traps are covered with "roll-away" floors which can be placed in position when any trap is lowered. Between these movable traps and the footlights are three 50-foot traps with "roll-away" floors.



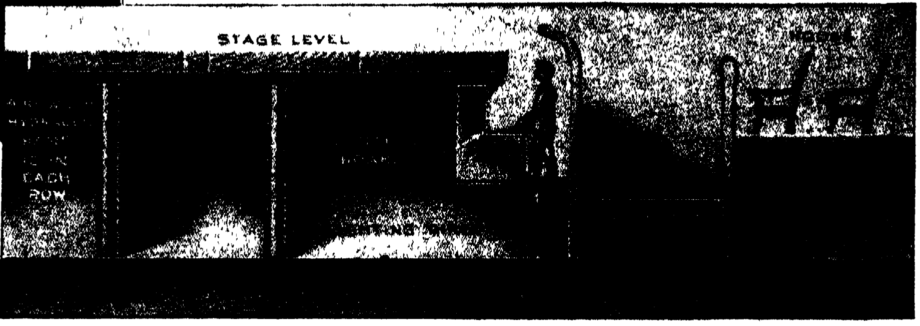
THE GOLDEN CIRCLE

The luxurious box floor of the new Civic Opera House taken from the right-hand side of the auditorium. The chairs for the ladies are made lower than for gentlemen. There are no pillars to interfere

THE COMFORTABLE ORCHESTRA

The musicians are in a pit. The aisles are numerous, so access to any seat is simple. The hydraulically operated steel fire-curtain symbolizes many popular operas by means of pageantry

THE LIGHTING OPERATOR AT WORK
In front of the curtain, the "lighting operator" will control the stage and house lighting as easily as the orchestra conductor directs. The lighting control board is shown above



At the back of the stage is another trap, the giant of them all. It measures 75 feet in length by five in width. It can be lifted five feet above the stage level and dropped 35 feet below. In the vault into which this trap descends are located racks to accommodate the hundreds of drop-curtains required in a season's production of opera. Every rack is neatly labeled with the name of an opera. In all, storage for 2000 drop curtains is provided. The vault containing the racks is fire-proof and damp-proof, insuring complete protection of equipment.

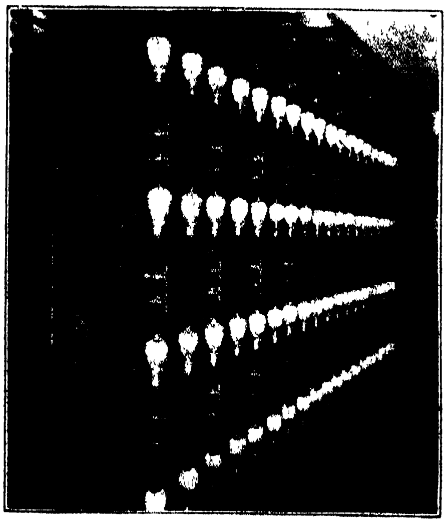
Just back of the footlights a steam curtain is provided for scenic effects. There are two fast-working curtains immediately behind the proscenium, operated by horizontal hydraulic machines. One of these machines is used for the drape curtain and the other for the act curtain. Each is controlled from the right side of the stage.

STILL another hydraulic machine operates the huge steel curtain, which can be controlled from either side of the stage. The curtain weighs fifteen tons, and consists of flush steel plates on its face, braced and trussed at the back. It is covered with vitrified asbestos, and the face is decorated with a symbolic painting harmonizing with the decorative scheme of the auditorium.

Drops for from three to ten operas might be hung at one time on the scenery "pipes" of the new theater. They are 106 in number, each 70 feet long, and with a clear lift of 144 feet. At the sides and rear of the stage are three cyclorama frames, eight inches apart, extending from within about five feet of the proscenium opening to within three feet of the back wall, and completely surrounding the stage. They are 240 feet in length and 115 feet high. The frames lift 38 feet above the stage floor, and are suspended by steel tape with channel-iron framing. The lifting and lowering of the cycloramas is controlled from the central control station on the right-hand side of the stage.

To light this huge structure—certain scenes in opera require light more intense than daylight—ample provision has been made for bank-lights in the wings on either side of the stage, for border-lights directly above the stage, and for spots, bunch-lights, footlights, and flood lights.

There are 16 bank-light frames, eight on each side of the stage, between the cyclorama frames and the counter-weight pipes. There are nine rows of border-light pipes, each 16 feet long. All sections of every row operate independently of one another, and all travel from stage floor to gridiron. There are also three light-bridges for spot lights and arcs. Two are located three feet from the proscenium wall, one above the other, traveling in fixed angle guides, while the third swings free directly over the seventh row of border lights, and is used for lighting the cycloramas. Lifting and lowering of the light bridges is controlled from the main rigging control station and also from controls located on the bridges themselves.

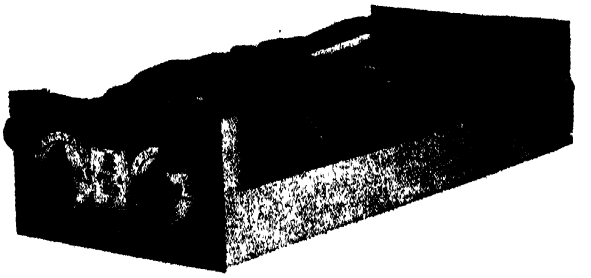


RECTIFYING TUBES
The new control scheme involves the self-synchronous motor and vacuum tubes

There are twelve "spot lines," six on each side of the stage. They cover practically every square inch of the stage, and all are mounted on cars which travel up and down stage and can be locked in the desired position. More than a hundred hoisting machines are required for this quantity of equipment, of which 61 are controlled from the main control board and a portable control board, worn by the chief electrician when directing the placing of his lights. Remote control is used throughout the stage, not only for raising and lowering the lighting equipment and some of the scenery, but also for dimming and brightening the lights, cutting out sections, changing lighting, et cetera.

Aladdin, with his wonderful lamp, has been outdone in this electrical installation, conceived and designed especially for the Chicago Civic Opera Company's needs by the General Electric Company. The system, which involves new and unique principles and which minimizes time, labor, and valuable space, enables the lighting director to leave his position back stage for the first time in theatrical history and take up a position in front of the curtain along with the prompter.

In front of the curtain, the lighting operator controls the stage and house lighting as easily as the orchestra conductor directs the orchestra. In front and on each side of him are arranged dials, knobs, tumbler switches, indicating lights, and so on. By the



VOLTAGE REGULATOR UNIT
The "Selsyn" receiver is the same type of control as is used in the Panama Canal locks for controlling the gates

mere manipulation of a single knob all the complexities of stage lighting are controlled, lights of various colors fading and brightening at various points and at the proper moments. Scenes requiring complex lighting effects such as sunsets, sudden thunderstorms, ballet lighting, et cetera, require no more effort for their control than is needed to flick a lighting switch in the home or to turn a door knob.

The advantages of the new method are manifold. Heretofore, the control of theater lights has been centralized in a switchboard back stage which, in the larger theaters, might be as much as 40 feet long by 8 feet high. The operation of the dimmers required much physical effort and agility, and many elaborate and ingenious mechanical schemes were often resorted to in order to simplify the work. Their manipulation made it necessary for the electrician to be at a point "off-stage" where he could not see, except indirectly, the effects he was producing and where he had to rely on cues of words or sounds to inform him when it was necessary to change the lighting effects.

PORTABLE CONTROL STATION

These stations control as much as 500 horsepower used for hoisting everything

For lighting the stage there are 141 individual circuits, each including lights of but one of the four colors used on a theater stage—amber, white, blue and red. The lighting operator could control the lights by manipulating knobs on every individual circuit, but to do so would involve the operation of as many as 141 knobs. A method has been devised, therefore, to govern all the lighting circuits through one knob, or to split the control into major and minor divisions, depending on color, location and function, each group in turn controllable through the agency of a knob.

THE individual circuits are grouped under the control of master knobs governing, for example, all the blue lights in the borders and footlights, all the amber in the pocket lights, all the white in the light bridges, and so on. In addition, all the lights of each color, no matter where located, are controlled by a color master knob. Finally, all the color masters may be operated simultaneously by a grand master knob.

The energy required for the control of any of the individual lighting circuits is approximately one tenth that consumed by a pocket flash light. The energy controlled, however, may run as high as 30,000 watts in a given circuit. The total energy used in maximum lighting effects may be as much as 1250 kilowatts or nearly 1700 horsepower of electrical energy.

Tucked away in the north wing of the building is the Civic Theater which seems a midget in comparison with the Opera House. The auditorium measures 80 by 57 feet, and the height is 47 feet. The stage is 70 by 32 feet, and the height to the gridiron is 71½ feet. Its equipment is very much like that of the Opera House, on a correspondingly smaller scale, but just as complete in every detail.

THE GRIDIRON FLOOR

The gridiron floor is 145 feet above the floor of the stage. The vast lifting equipment is the last word in stage economy

The total load on the foundations of the large edifice is about 202,000 tons, including live loads. At 28 feet below the water level (Chicago River) there is a connection with the system of the Chicago Tunnel Company, by which coal is delivered to the boiler-room and ashes are removed without being taken above ground.

The fire protection is most complete and a large automatic fire-door in the roof over the stage is arranged to open automatically in case of fire and thus keep flames and gases from spreading into the auditorium. The architects were Graham, Anderson, Probst, and White of Chicago, who are also the architects of the Shedd Aquarium and the Merchandise Mart, interesting examples of the art of the construction engineer.

PAINTING THE GREAT CYCLORAMA

Forty men covered 3000 square yards in two and three quarter hours. The huge surrounding cycloramas are 240 feet in length

A MAZE OF RIGGING

View from the upper machinery floor showing the cyclorama frames, the border lights, and the fly floors in the background

The Business Executive Takes to the Air

Survey Shows Many Firms Operate Company-Owned Planes

By DOUGLAS W. CLEPHANE

DICTATING AMONG THE CLOUDS

Mr. J. H. McDuffee, a well-known executive, using the equipment provided in a modern "flying office"

RECENTLY the general manager of a large banking corporation with branches in 500 cities was confronted with a problem. Within one week he had to hold conferences in ten cities, including New York, Cleveland, Kansas City, Denver, and San Francisco.

To accomplish this, traveling by train would have required three times the time at his disposal. The board of directors called in the sales manager of a well-known airplane manufacturing company and asked him to prove to the satisfaction of the board that this trip, as well as other business trips, could be made in a company-owned airplane, with assurance that the conference dates could be kept and that the executives would not be subjected to an undue risk.

To the officials of the company, the purchase of a company-owned airplane was a radical departure from their previous methods of doing business. To their amazement, the sales manager showed them that 170 business corporations now own one or more airplanes, that some 30 companies are operating more than one ship, and that at least 10 firms have fleets of six or more planes.

Still not satisfied, the directors wanted to be shown that air travel was safe. As their president expressed it, "It is highly important that these conferences be held on scheduled time. We can save thousands of dollars a year if we can reduce the time our executives spend in automobile and railroad travel. However, if one of these men should be injured or killed, we would suffer a tremendous loss."

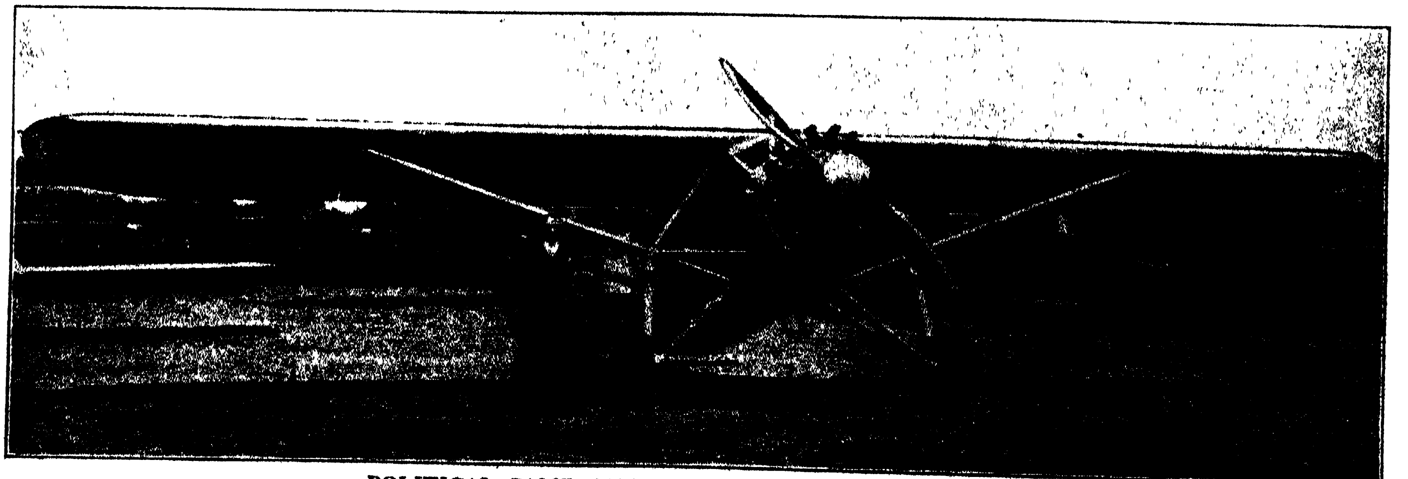
The sales manager, who had met this problem many times before, produced figures compiled by the United States Department of Commerce, showing that there have been fewer casualties on air transport lines considering the number of miles flown and the number of passengers carried, than on the railroads having the highest standards of safety.

He proved to the satisfaction of the skeptical board that modern planes operated by competent pilots have achieved such a remarkable record for safe flying, that travel by other means should not be undertaken without serious consideration of the dangers involved.

Willing to concede that a company-owned airplane would save their executives' time without unnecessary risk, the directors wanted to know if the operation of their plane would involve unwarranted expense. Figures were presented, compiled from complete cost records kept by a dozen corporations which had operated their planes a total of nearly 500,000 miles, showing that the cost of operation of a modern six-place cabin plane would run approximately 23 cents a mile, based on 500 hours operation a year.

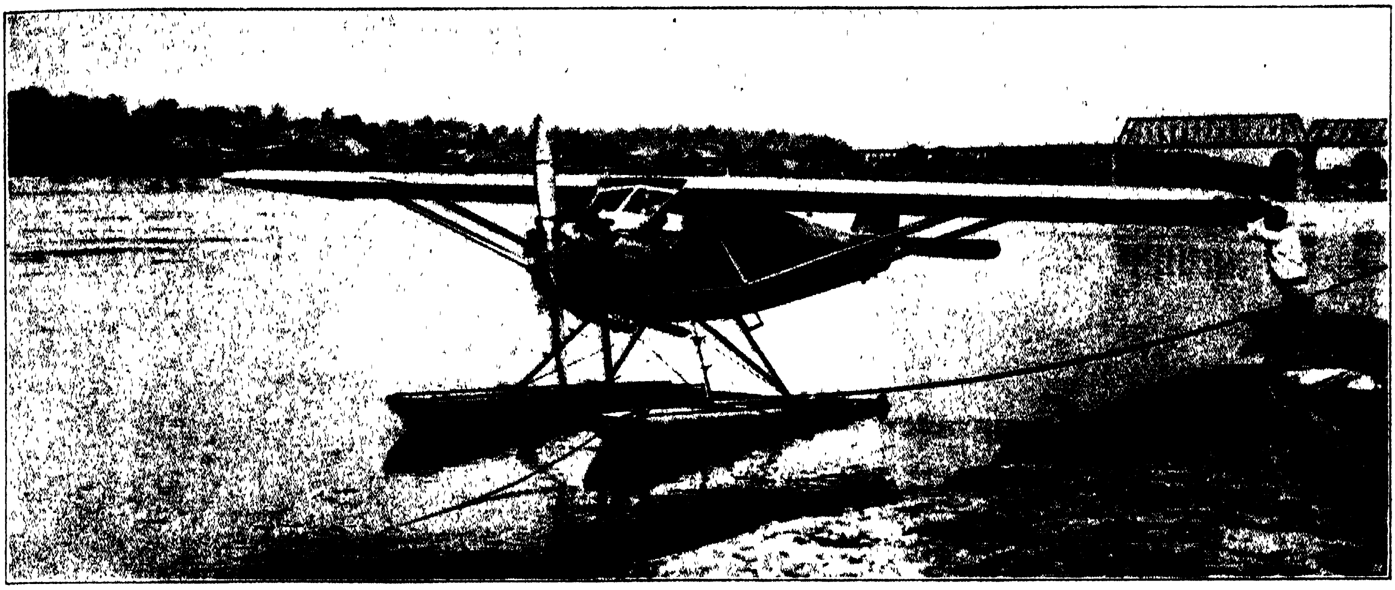
THESE figures included the salary of a full-time pilot, complete insurance coverage, depreciation, interest on investment, cost of overhauls, hangar rent, gasoline and oil, and all other direct and indirect expenses. When a full load was being carried, the cost per passenger would run only a trifle over railroad fare.

Most of the members of the board were convinced, but the chairman, remembering a flight taken in a rebuilt war-time plane five years ago, objected to the discomforts involved in flying. "When I start out for a business trip," he declared, "I don't want to have to clamber up the side of a dirty cockpit. When I arrive for a conference I don't want to be covered with overalls, goggles, a parachute,



POLITICAL CAMPAIGNING WITH A CABIN MONOPLANE

Governor Walter Kohler of Wisconsin recently conducted his campaign for re-election with the aid of this airplane. By flying from town to town, a politician can deliver three times as many speeches as usual and has adequate facilities for preparing his talks *en route*



ANOTHER TYPE OF AIR TAXI POPULAR WITH BUSINESS MEN

Seaplanes and amphibians are rapidly becoming popular with business men for commuting and general business usage, because of the fact that they do not need prepared landing fields. An amphibian is at home on land or water. This picture shows a new Ryan seaplane

and other flying paraphernalia as if I were a circus performer. Flying is undignified, uncomfortable and does not yet offer the traveling comforts to which I am accustomed."

In answer, the sales manager persuaded him to go to the airport and witness a demonstration of a new cabin plane which typifies the trend toward limousine comfort in privately-owned airplanes. He inspected a plane which still follows closely the sleek lines of the famous "Spirit of St. Louis," made by the Ryan Aircraft Corporation. The banker had been closely identified with Colonel Lindbergh's flight, but had not followed the great strides in airplane design made during the past two years.

HE was surprised to find that the seats in the plane, which accommodates five passengers in addition to the pilot, were as comfortable as those in the most luxurious limousine. He found the enclosed cabin as carefully upholstered as the cabin of a fine yacht, equipped even to flower vases and cigarette cases. He was delighted to learn that he could see as well through the curtained windows of the airplane as he could from his own motor car.

The chairman was told that parachutes are no longer necessary as safety devices, and are not used except by student pilots and instructors, stunt flyers, and by pilots who must fly in all kinds of weather. He was amazed when told that the plane could be equipped with a self starter, and that non-shatterable glass was used.

He was even more surprised when shown a "flying office" model, equipped with office desk, dictaphone, filing equipment, book case, thermos bottle set, electric cigar lighter, and other conveniences found in an executive's home office.

After accepting an invitation to take a flight, the banker gasped with amazement when the pilot removed both hands and feet from the controls, allowing the ship to maintain a compass course for five minutes without any attention whatsoever. Finally he took the stick himself, for the first time in his life, and found that holding a modern plane on a course, in smooth air, is no trick at all.

The board was convinced, the purchase followed, and in the first month of plane ownership, 11,100 miles were flown over 32 states, 440 passengers were carried, and an average speed of 112 miles an hour was maintained, which is 30 miles an hour less than the maximum speed of the ship.

MORE ORDERS PER SALESMAN

George Fridell, a salesman with a western fuel company, considers a plane "indispensable" in his work

So successful has been its operation, that the company has calculated that the plane has shown a profit of 8000 dollars in its first six months of operation by conserving the time of highly paid executives. This does not count the indirect saving from closer supervision of all activities of the company, the advertising and publicity value, transactions closed where it would have been impossible to get a man on the ground in time by any other means of travel, increased prestige, and other intangible advantages.

This case has been followed through somewhat in detail because it is typical of the problems that confront many other companies today.

ONE of the leading manufacturers of airplanes recently made a comprehensive survey of the business use of airplanes, finding that 170 firms in 45 types of business are now operating one or more airplanes. Inquiries from large corporations are being received at the rate of from 10 to 20 a week, and a recent mailing to hundreds of executives brought the information that 60 percent of the companies represented were considering the purchase of an airplane in the near future.

A few years ago an airplane was an object of curiosity and attracted a crowd wherever it landed, drawing attention to the name of the firm and its products. Many companies carried this further and installed flying displays of products, dropped samples and advertising literature and carried on other promotion stunts from the sky. So great was the advertising and publicity value that executives were inclined to overlook the airplane as a daily means of transportation.

LAWYER-PILOT

Charles L. Morgan, prominent attorney, owns and pilots his own cabin plane

Today the use of airplanes still draws some attention to the owner, and the arrival and departure of a plane in the smaller towns still receives news items in the local papers. It furnishes a valuable means of creating good-will among clients and others with whom the firm does business, but undoubtedly its greatest value is as a means of fast transportation. Airplanes are applicable to any line of business where dealings are conducted over a large territory requiring much travel by highly paid salesmen and executives.

CHARLES L. MORGAN, a well-known attorney for oil and gas companies in the southwest, was one of the first men in the legal profession to see the need of fast transportation. His statement of the use he is making of his cabin plane is an illustration of the modern tendency to apply air transportation to business.

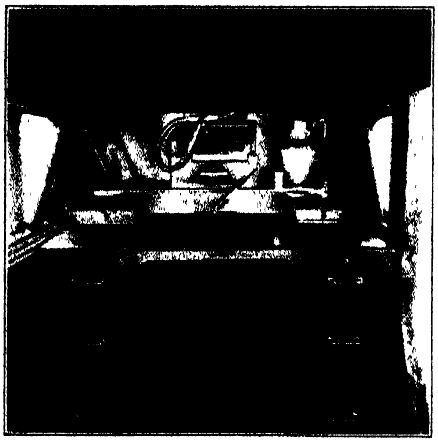
"My plane reduces the state to about the size of a county, if I were using an automobile. Moreover, air transportation is much more comfortable, easier, and cleaner. Personally, if I drive an automobile three or four hundred miles, I am tired, while with the plane, I can do a 1000 miles, accomplish a day's work, and not be any more tired than if I had been sitting behind my desk all day.

"Practically, it works out this way: previously if a client sent me to some remote point in western Texas, I spent two days going, worked one day, and spent two days returning. The client has to pay while I am traveling because he is taking my time. Assuming that my charges are 100 dollars a day and expenses, one day's work cost him 500 dollars plus expenses. With my airplane, I am off right after daybreak. By nine or nine thirty, I am at my destination at work, and at night I am home as usual. I can charge him 250 dollars. My client has saved more than half and obtained quicker action, and I collect 250 dollars per day instead of 100 dollars."

Many salesmen are becoming sales engineers with specialized technical knowledge in addition to their ability to make sales and hold the good will of customers. Such men are rare and often receive more than 10,000 dollars a year. It is an economic waste to allow such a man to spend half of his time in travel, when the investment of a few thousand dollars in an airplane will allow him to treble the time he spends in constructive work.

Edward S. Evans, president of the Detroit Aircraft Corporation, which controls 11 well-known aviation companies, and who is associated with many other business enterprises, recently said, "I believe that in a few years the companies that do not furnish their best salesmen with airplanes will be as out of date as the firms that had their salesmen traveling in buggies when their competitors were using motor cars."

Another use to which airplanes are readily adaptable is the delivery of equipment and parts required in a hurry. At least 20 oil companies are using airplanes for this purpose. Other industries also are finding the airplane invaluable in this type of service. When a machine breaks down, tying up a whole plant or department, expense is a minor factor compared with the time lost in getting replacements. Several of the more progressive machinery manufacturing companies maintain their own planes for quick delivery service.

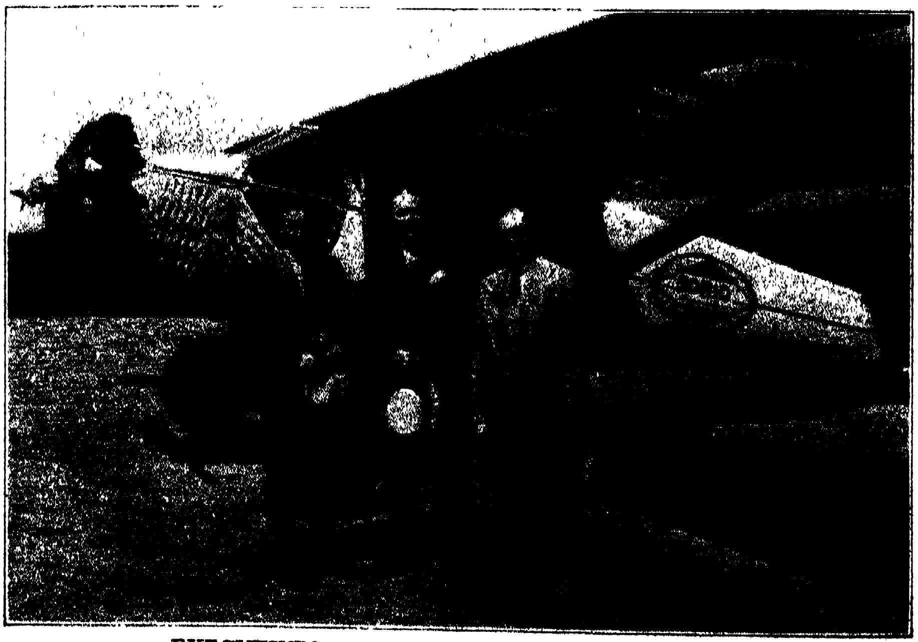


THE RYAN FLYING OFFICE

This cabin model, designed for business executives, is equipped with all appurtenances for transacting a day's work

TOO much emphasis has been placed on the romantic and unique uses to which an airplane can be put, so that many business men have overlooked the practical value of air transportation in daily work. The writer believes that five years from now, instead of 170 business firms owning airplanes, there will be thousands. The practicality of the "flying office" has been proved and about 20 such planes are now in use by presidents and executives of large corporations. Piloting the newer planes is much more simple than formerly.

Just 100 years ago school trustees in an Ohio town refused the use of a school for a debate on the subject, "Is the Steam Engine Practical." The school trustees wrote, "If God had intended that His beings should go at the unholy rate of fifteen miles an hour, He would have so declared in Holy Writ." A few executives of business corporations still assume somewhat the same attitude toward the adaptation of air transportation to their businesses.



EXECUTIVES AND PILOT READY TO TAKE OFF

Left to right: Pilot Dewey Noyes with Mr. A. M. Maxwell and Howard G. Jones, officials of the Standard Oil Company of Ohio, about to leave Cleveland Airport on a short journey

A Big Practical Problem for Science*

What Will Be the Power Source of the Future, When the Coal Supply of the World Is Exhausted? Photochemistry Offers One Possibility

By PROF. F. M. JAEGER

The University of Groningen, the Netherlands
Non-resident Lecturer in Chemistry at Cornell University

IT is a well-known fact, that, both for the biological processes in plants and animals as well as for the maintenance of human civilization, a continuous import of energy from outer space to our planet is necessary. The only source of energy that practically needs to be taken into account in this respect, and which daily furnishes enormous quantities of energy, is our sun. In whatever form we meet with energy on the earth, whether it be stored in coal or oil, or be immediately available to us, as in the flowing or falling water, or in the winds, it can in all cases easily be understood that this energy has always its real origin in that of the radiation which the sun continuously emits in all directions into space and some of which strikes the earth.

Courtesy of Dr. Charles G. Abbot

ABBOT'S EXPERIMENTAL SOLAR COOKER

Dr. Abbot, Secretary of the Smithsonian Institution, devised this cooker, installed it at Mount Wilson Observatory and cooked with it. The parabolic aluminum reflecting surface focuses the sun's heat on a pipe which conducts hot oil to a reservoir. Cooking and baking temperatures up to 447 degrees, Fahrenheit, are obtained. The heat can be stored all night

If this radiation is absorbed, it will for the greater part be transformed into heat, which causes the water on the earth to evaporate, and thus gives rise to the mighty formation of clouds. Inversely, the condensation of this water vapor is the cause of rain and snow fall, which in their turn feed the rivers, seas, and waterfalls. The differences in temperature and pressure in the earth's atmosphere that are brought about under the influence of the solar radiation are the causes of air-currents which give rise to the energy of the wind. The radiant energy of the sun given out several hundreds of millions of years ago is now stored up in the form of chemical energy in coal, after having been transformed and accumulated in the living vegetable cells of those far-off eras. Through the process of combustion, this stored-up chemical energy is used by us in our steam engines and gas motors of to-day. This stock of coal, and also of mineral oil, nowadays represents the principal source of energy that man utilizes for the production of mechanical power.

There is no other source of energy on the earth the output of which can even distantly be compared with that derived from the two sources just mentioned. We can safely say that practically our whole need of energy is supplied by that fossil stock of solar energy which is at present stored in our deposits of coal and oil. The necessary consequence of this is that we draw upon our energy capital to so great an extent that it must finally become exhausted, unless some way be found to replenish it by again accumulating this mighty solar radiation against the day when our stores of coal and oil will have been exhausted.

The total quantity of coal on the earth seems not to exceed about 2000 billion tons, of which at the present time about one and one half billion tons are used annually. This yearly consumption, however, is increasing so rapidly that our coal deposits will hardly be sufficient for another thousand years, a period that is very short in comparison with the length of the future existence of mankind on the earth.

BUT the exploitation of the coal deposits that still remain will become impossible long before that time, both for technical and for economic reasons. Within a period much shorter than these thousand years, the ominous consequences of the present reckless demolition of our coal fields will make themselves seriously felt, for the simple reason that the coal must be extracted from ever deeper and deeper levels with consequent rapid increase of the cost of mining.

The question as to whether it then will be possible to obtain the indispensable energy from other sources on earth must, so far as can now be judged, be answered in the negative. Again at the instigation of Sir William Ramsay, the possibility of such an eventual development of other energy sources was in 1910 seriously investigated in England by a number of competent men. On that occasion the possibilities were taken into account of making use of the ocean tides, of the internal heat of the earth, of the energy of the winds and waterfalls, of the kinetic energy of the earth's rotation and of its yearly motion in space, of the chemical energy of wood and peat supplies, and finally of the intra-atomic energy of the atoms of the elements.

This official inquiry showed that the application of the internal heat of the earth, of the kinetic energy of the earth's motions, of the energy of the winds, and the use of wood and peat supplies never would be of any significance for the solution of the problem in comparison to the enormous quantities of energy yearly furnished by our resources of coal and oil. The energy that could be obtained by the disruption of the atoms of our chemical elements would be enormous in amount, but we need not further consider it at this time because in the opinion of our ablest scientists the practical accomplishment of this objective will be achieved only in the far distant future, if ever.

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* From the George Fisher Baker Lecture, delivered at Cornell University, and reprinted by courtesy of *Science*.

The available water-power on the earth would, according to Engler, amount to about the energy of 70,000,000 tons of coal annually; that is, to about 4 percent of the energy necessary every year. Of course, the total water-power present on earth is much greater, but an appreciable part of it will probably never be available.

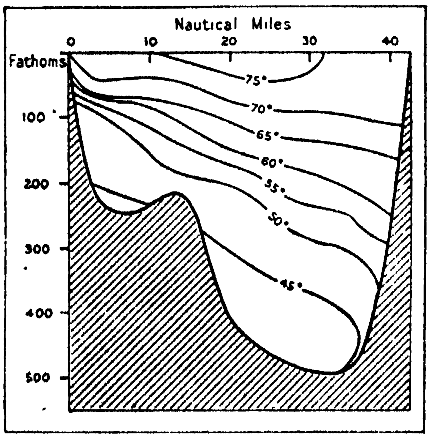
A CALCULATION made in 1922 by Steinmetz seemed to indicate that the energy of the flowing water, corresponding to the yearly amount of rain in this country, would be almost equivalent to that of your yearly coal consumption. Spoehr, however, has emphasized that these calculations are totally theoretical, as a great part of that energy is inaccessible and the distribution of the remaining energy over such an extensive territory would meet with almost insurmountable difficulties.

Therefore, in this respect, America is, for the time being, dependent in a large degree upon her own resources of coal and oil, of which the latter seems to be rapidly approaching final exhaustion, notwithstanding the apparently reassuring fact that new sources of limited extent are frequently being developed.

The possible use of the low and high tides of the sea has occupied the attention of various inventors since the 15th Century. Indeed, the periodically alternating low and high ocean tides would furnish gigantic quantities of energy if it were only possible to use them for mechanical purposes in a not too expensive and complicated way.

In recent times several solutions of this problem have been proposed, some of which have already found a practical application, although only on a relatively small scale, in France, in England, and in several places in Germany (Ditmarschen, Husum, Hüll). The systems with two large communicating water reservoirs, instead of those with a single one, seem to be preferable, as they allow an uninterrupted action both day and night, even during neap tide. Their theoretical efficiency, for a difference in sea-level of about ten feet is, however, less than that of a system with a single tank, and is not greater than about 12,400 kilowatts for each sea-tide and for each square mile of surface of the reservoirs, and in practice this efficiency is appreciably diminished by a number of uncontrollable factors, as, for example, the irregularities in the level-differences of the tides, to the square of which the energy output is proportional.

Such a plant would be extremely expensive and its maintenance would be very costly. Consequently it could economically be operated only under very favorable local conditions. It is therefore probable that no satisfactory solution of the problem of the production of energy in this manner is to be expected.



By Marmer, after Wust, courtesy of the Geographical Review

GULF STREAM TEMPERATURES

Cross-section of Gulf Stream through Straits of Florida, Cuban shore at right

Recently, however, there seems to be indicated another way of energy production from the sea, which, in my opinion, may become of high significance in the future. I refer to the experiments of G. Claude and P. Boucherot upon the utilization of the relatively small but very constant temperature-differences that exist throughout the year between the sun-heated surface of the tropical oceans and their deeper layers, the temperature of which is kept at from 37 to 39 degrees, Fahrenheit, by the cold polar-sea currents.

IN 1913 your countryman Campbell pointed to the possibility of obtaining mechanical or electrical energy by means of these very constant temperature-differences, and in 1923 Romagnoli, Dornig, and Boggia made analogous propositions. It was, however, only recently that the well-known French chemist Claude and his collaborator Boucherot succeeded in giving experimental proof of that possibility. They were able to demonstrate that a small Laval turbine designed to be driven by steam within pressure limits ranging from 300 to 3 pounds per square inch can advantageously be driven by water vapor with tensions between only $\frac{3}{5}$ and $\frac{3}{20}$ of a pound per square inch, corresponding to temperature-differences between 77 and 44 degrees, Fahrenheit, only.

According to their calculations and experiments, a net output of 388,000 foot pounds could be obtained from each cubic meter of water between 82 and 39 degrees, Fahrenheit, if there be subtracted the energy that is necessary for pumping the cold and air-free water from the depths of the ocean to its surface. An installation of this kind having a capacity that effects the displacement of 35,300 cubic feet of cold water every second, would be able to produce 400,290 kilowatts of electrical energy, this efficiency being about 30 or 35 times as great as that of a low and high tide plant of the same dimensions.

In their provisional installation at Ougree-Marihaye, Claude and Boucherot recently demonstrated before a meeting of engineers that a turbine could be run by utilizing the slight temperature-differences of the water of the Meuse, ranging only from 82 to 44 degrees, and that it could drive a dynamo with a capacity of 59 kilowatts. The calculations by Boucherot of the necessary costs of installation seem undeniably to indicate that the practical realization of this idea lies very probably within the limits of technical possibilities.

THE question as to whether it would be possible to use our present stocks of coal and oil in a more economical way than is now usually applied is of high importance and has often been the subject of discussion and investigation. In the present exploitation of our oil fields, about three fourths of the oil remains in the soil. This needs, in the future, to be recovered by some process suitable to the purpose.

Even the continuous improvement of the steam engine, or its substitution by turbine or gas motor, can not eliminate the ominous fact that the greater part of the heat of combustion of the coal and oil will, when thus used, always be wasted. At the present time it seems that the most effective way of limiting, as far as possible, this squandering of energy consists in the combustion of the coal at the mines themselves, and the immediate utilization of the heat of combustion for the production of high-tension electric currents.

It is possible that some way may be found for transforming the potential energy of the coal directly into electrical energy, but experiments along this line have not yet met with practical success. None of the so-called "fuel batteries" constructed for this purpose in the last decade can be considered as being adapted to practical development, because their current efficiency, even at higher temperatures, remains in each case much too small by reason of the unsatisfactory reaction-velocity of the electrochemical processes going on in them.

As the matter now stands, we can say that in answering the question as to how to make the future necessary energy production most completely independent of the fossil stocks of energy accumulated in former geological periods, we are chiefly confined to the mighty current of radiant energy that is flowing to us directly and continuously from the sun. This quantity of radiant energy appears to be stupendously great, but it is now almost completely lost by dissipation. Some data may give you a clearer understanding of this fact.

According to Langley's measurements of the solar constant, each square meter of the earth's surface receives, every hour, a quantity of radiant energy that is equivalent to 1800 calories. If we regard the sun as limiting itself to an eight-hour working day in tropical regions, it can be calculated that every square meter of the earth's surface receives from the sun's radiation a quantity of energy equivalent to the heat of combustion of 2.86 pounds of coal. For every square mile this is equivalent to 7400 tons of coal, which means that the total annual amount of energy produced throughout the world through the combustion of coal would be equaled by the radiant energy of the sun which, during a like period, falls upon a surface of only 1275 square miles. The desert of Sahara has a surface of about 2,300,000 square miles, and therefore annually receives a quantity of solar energy that is equivalent to more than 1800 times that derived from the world's total yearly consumption of coal.

At present this enormous quantity of energy is almost completely lost; only three percent of it is absorbed and used by the living plants on the earth. Although this percentage is a very small one, the total quantity of radiant energy annually absorbed in this way over the whole solid surface of the earth still amounts to about 15 times the yearly world consumption of coal. But the question arises as to whether and in what way it would be possible to catch the enormous quantity of solar energy that now is dissipated every year, and to apply it to the production of mechanical and electrical energy.

In the consideration of this question two points should be emphasized at the outset; first, the necessity of concentrating and accumulating the solar energy supplied to large surfaces; and second, of absorbing this solar energy to the greatest possible extent. Absorption must precede the transformation of radiant energy into those other forms in which it can be used for our immediate purposes. After absorption, the solar energy may be immediately transformed into heat which may then be utilized in the usual manner for the production of mechanical work, or the radiant energy may be absorbed by special substances in which it sets up a "photochemical" reaction and thereby produces a certain amount of chemical energy. The chemical energy can afterwards be changed into another form of energy suitable for our use.

DR. CLAUDE AND HIS FAMOUS EXPERIMENT

He first demonstrated the principle involved, on a laboratory scale, before the French Academy of Sciences. Now he is installing a full-scale plant in Cuba, at Matanzas Bay

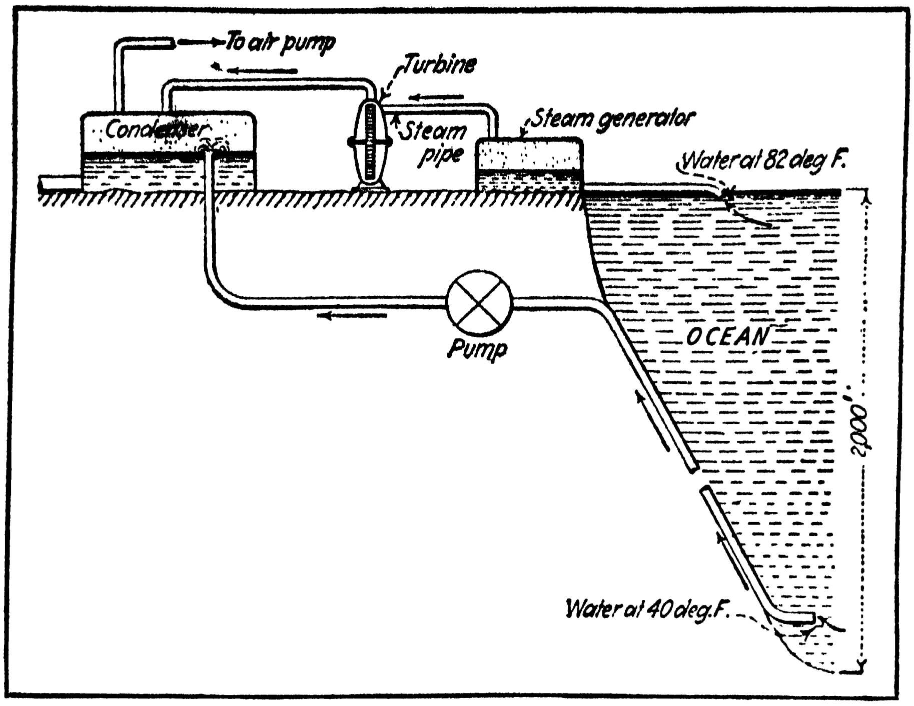
Nature has solved the latter problem of utilizing the solar energy through a most remarkable photochemical process in which that mysterious laboratory which we call the "living vegetable cell" is involved. The plant utilizes the radiant energy of the sun to synthesize a large number of complicated chemical substances in its protoplasm. These compounds accumulate in the plant organism, and their stored chemical energy can later be employed for the production of mechanical work. We also know of other photochemical reactions in which a fraction of the absorbed radiant energy is immediately transformed into electrical energy. I will discuss these more fully later on.

Let us first consider the other and simpler case of utilizing the solar energy by first concentrating and absorbing it, and then transforming it into heat.

Concentration of the radiant energy may be effected either by means of large lenses or by a system of mirrors; the absorbent heat-reservoir is placed at the focus. In actual practice, only systems of mirrors have been used. These are mounted on a light frame which permits them to be easily rotated, which is, of course, necessary because they must follow the apparent motion of the sun in the sky. The radiant energy concentrated by these mirrors falls upon a metallic reservoir which is blackened on the outside and which contains some volatile liquid that shows a considerable vapor tension at relatively low temperatures. Ammonia, sulfur dioxide or certain organic liquids of low boiling point are employed.

An example of this type of installation is that devised by Shulz, in which, using sulfur dioxide, an output of about one horsepower was obtained for each square yard of surface of the absorbent reservoir. At the ostrich farm in Pasadena they have used, and perhaps still are using, a conical aggregate of mirrors of 32 feet diameter, in the focal line of which a steam boiler was placed. This developed steam at a pressure of from 150 to 225 pounds per square inch after only one hour's exposure to the sun, and the device was used for pumping water at the rate of about 2000 gallons per minute, and for driving a dynamo.

It may be possible that in dry and tropical climates this method of utilizing solar energy may be successful on a small scale, the cost of the equipment being compensated by the fact that the expense of operation is very low. But under less favorable conditions this device can never be expected to yield a satisfactory solution of the problem because it concentrates the radiant energy that falls on only relatively small surfaces. The proposal of Claude and Boucherot offers much greater promise in this respect because it utilizes the



SCHEMATIC LAYOUT OF CLAUDE-BOUCHEROT PROJECT

Water becomes steam at air temperatures if air pressure is greatly reduced. Claude and Boucherot do this by condensing the exhaust from the turbine with cold bottom water

energy that is accumulated over the immense surface of the ocean during long intervals of time.

These considerations lead us to the conviction that the final solution of the problem must be sought rather in the utilization of specific photochemical reactions of the radiant energy. I intentionally use the word specific here because experience has shown us that the action of radiation upon chemical substances is highly exclusive in character. The assimilation of carbon dioxide by plants is a well-known example. The radiation is here absolutely necessary for bringing about this reaction which goes on at ordinary temperatures, the living cell being able under the influence of sunlight and with the aid of its chlorophyll to synthesize a number of complicated substances which we in the laboratory, in spite of the high development of synthetic chemistry at the present time, are able to produce either not at all or only with great difficulty, even when high temperatures and powerful agents are employed.

We are still dependent, for the production of most of our foods and drugs, upon photochemical processes that proceed under the influence of solar radiation in the plant cells. Although it seems possible, according to the experiments of Ciamician and Ravenna, to influence these processes within certain limits by special external stimuli, we really as yet have little understanding of the true mechanism of these reactions. But the researches of Baly, which have shown that moist carbon dioxide may, in the presence of certain substances such as compounds of cobalt or nickel, be transformed through the influence of ultra-violet light into substances like sugar, have demonstrated that it is possible to produce, in the laboratory, compounds that are formed in the natural processes of the living plant.

No one as yet has succeeded in carrying on this photochemical synthesis on a large scale. It offers, however, an alluring prospect because, according to Brown's investigations, if it is assumed that a quantity of solar energy equivalent to five calories will transform one liter of carbon dioxide into sugar, and if only 4 percent of solar energy during an eight hour day is assumed to be photochemically active, it would be possible in this manner to produce 374 pounds of sugar every day by the use of a tank having a surface of only one hundred feet square. This amount of sugar, besides its value as a nutriment, would, if used as a fuel, be equivalent to about 154 pounds of coal. It is extremely doubtful, however, whether this method of utilizing solar energy will ever be brought to practical success.

The remaining possible solution of the problem of utilizing the radiant energy of the sun for the production of mechanical work is the application of reversible photochemical reactions which proceed in such a manner that the absorbed radiant energy may be converted into a usable form such as electrical energy. If the reversibility of such photochemical reactions is nearly quantitative in character, the photosensitive system of substances will then, in respect to solar radiation, play a rôle analogous to that of the lead accumulator in respect to electric energy. We might term such instruments "radiation accumulators"; they would be exposed during the day to the solar radiation which would cause a certain photochemical reaction, and then at night when left in the dark this reaction would reverse, the materials would return to their original condition, and the radiant energy absorbed during the day would be set free and stored up for mechanical uses.

It has long been known that such reversible photochemical processes really exist. For example, if a solution of mercuric chloride and ferrous chloride in water is exposed to light radiation, a reaction takes place in which certain amounts of mercurous chloride and ferric chloride are formed, a chemical equilibrium between the four salts being finally reached. If now this solution is placed in the dark, the sub-

Drawn from data published in *Le Génie Civil*

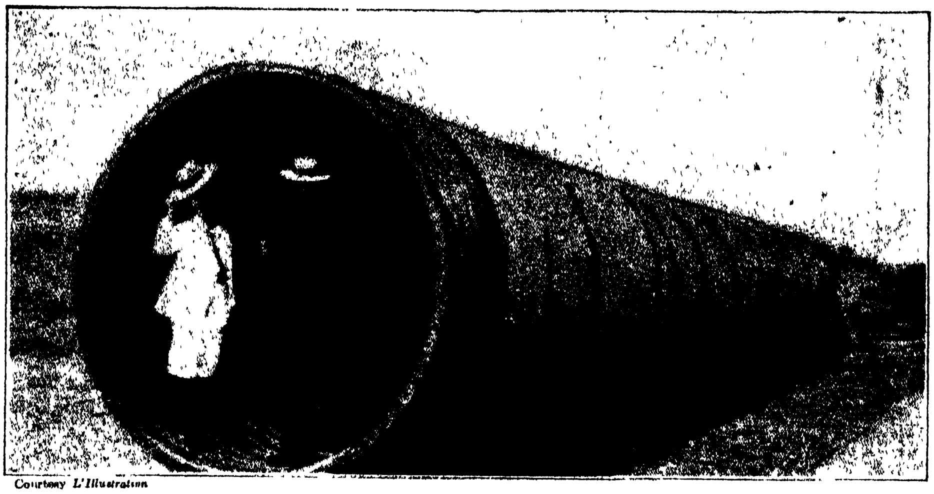
CLAUDE-BOUCHEROT PROJECT NOW UNDER WAY IN CUBA

The tube, seven feet in diameter, is made of corrugated iron. An accident to it recently delayed the project. In the drawing both vertical and horizontal scales are the same stances will revert to their original form, and during this inverse reaction the radiant energy absorbed will be completely set free in the form of electrical energy. It is possible to obtain a tension of 0.17 volt by means of such a photochemical cell; consequently a dozen such cells joined in series will yield the voltage furnished by an ordinary lead accumulator cell.

AGAIN, such a photochemical cell can be made by placing two platinum electrodes to an acidulated solution that contains potassium iodide and ferric chloride. When this cell stands in the dark, ferrous chloride and a certain amount of free iodine will be formed, the iodine remaining dissolved in the excess of potassium iodide. On exposing this cell to the action of light, the chemical equilibrium is displaced in the opposite direction, and potassium iodide and ferric chloride are regenerated. As with the previous cell the absorbed radiant energy is set free as electric energy.

Another remarkable example of a phenomenon of this nature is described by Rigollot. Two plates of red copper, each of them superficially covered with a thin layer of coprous oxide, are placed in a saturated solution of sodium chloride. If now one of these plates is exposed to light radiation and the other is kept in the dark, an electric current passes through the wire that connects the two electrodes. This current continues as long as the exposure lasts. The whole system returns to its original state in the dark. If the other electrode is illuminated, the electric current flows in the opposite direction.

These various experiments furnish definite proof that it is possible to convert radiant energy into electrical energy by means of reversible photochemical processes.



Courtesy L'Illustration

SECTION OF TUBING READY FOR INSTALLATION. CLAUDE PROJECT

The tubing is made of Number 7 gage sheet iron, is corrugated, very flexible, and light. The cold bottom water will be warmed only one degree in the pipe, it is estimated

There is, however, one great drawback to the practical application of such a method, and that is the very low intensity of the electrical current that is produced. The electrical work that can be done, which is a product of the voltage and current intensity, is, therefore, in all cases only extremely small. The explanation lies in the fact that the reversible transformations which take place in these cells are characterized by very small reaction velocities, and consequently the energy that is carried off can not be resupplied by the photochemical reactions with sufficient rapidity. The photochemical effect appears in general to be the strongest in those cases of reversible processes in which the oppositely directed reactions are slowest, and because of this fact, some investigators are inclined to doubt whether the utilization of such radiation accumulators can ever be of practical value. This opinion may, however, prove to be unduly pessimistic.

The construction of such cells is wholly a problem of reaction-kinetics. If it should prove possible to devise radiation accumulators or Volta-cells in which reversible and very rapid photochemical changes take place when radiation of such wavelengths as are contained within the solar spectrum is employed, the problem of using solar radiation as a source of energy might be regarded as definitely solved.

We are, however, still far distant from this goal. Photochemistry is still in its infancy and it has not yet outgrown the stage of mere empirism. It is quite possible, however, that when man's existence becomes seriously menaced because of a shortage of energy, photochemistry will rescue him from his distress.

The protection of mankind from this danger rests chiefly upon the physicist and the chemist, and they must ever be on the alert to find solutions for these intricate problems that involve the very existence of our race.

	Power Already Utilized			
	Horsepower	Percent of World Totals	Percent of Available Being Used	Total Horse-power Existing
Germany	1,100,000	3.6	55	2,000,000
Great Britain	250,000	0.8	29	850,000
France	2,100,000	6.9	26	8,000,000
Norway & Sweden	3,200,000	10.7	17	19,000,000
Switzerland	1,400,000	4.6	18	8,000,000
Spain	1,000,000	3.3	23	4,400,000
Italy	1,800,000	6.0	47	3,800,000
Russia in Europe	100,000	0.3	5	2,000,000
Rest of Europe	1,000,000	3.4	10	10,100,000
Europe	12,000,000	39.6	21	58,200,000
United States	10,000,000	33.0	29	35,000,000
Canada	3,200,000	10.6	12	26,000,000
Brazil	400,000	1.8	1.6	25,000,000
Mexico	500,000	1.7	8.0	6,000,000
Argentine	30,000	0.1	0.6	5,000,000
Rest of America	300,000	1.0	1.3	23,100,000
America	14,400,000	47.7	12.0	120,000,000
Siberia	90,000	0.3	0.2	51,000,000
China				20,000,000
Dutch Indies	80,000	0.3	0.5	15,000,000
Japan	3,000,000	10.0	21.0	14,000,000
New Guinea				10,000,000
British India	400,000	1.3	5.0	7,400,000
Rest of Asia				5,700,000
Asia	3,600,000	11.9	3.0	123,100,000
Africa	20,000	0.1	0.01	190,000,000
Australia	200,000	0.7	3.0	6,500,000
World Totals	30,000,000	100%	6%	497,900,000

From data in the Stone and Webster Journal

STATISTICS OF THE WORLD'S DEVELOPED AND UNDEVELOPED WATER POWER

The table shows that the world is using only 6 percent of its potential water power. Yet if every available hydraulic horsepower were to be used, the total would only equal half the present installed power from all sources in the United States alone. Water power is inadequate

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Exceptional Mastodon Bones Found

THE skeleton of a mastodon has just been unearthed in the village of Walnut, Indiana, and has been presented to Field Museum of Natural History, Chicago, by William and T. Bower, owners of the land upon which it was found. The skeleton was discovered by P. H. Yoder, local contractor, and his crew, while excavating an open ditch on the Bower farm.

Courtesy Field Museum of Natural History

P. H. Yoder, a contractor of Argos, Indiana, with skull and other bones of mastodon he discovered

Prof. Elmer S. Riggs supervised the excavation of the bones, which are probably between 25,000 and 100,000 years old. Included in the remains obtained are the giant beast's skull, tusks, teeth, jaws, and what are believed to be more than half of its body and leg bones. The find is regarded by museum authorities as extremely important, as it is seldom that such nearly complete specimens of these great creatures of the dim past are found. The new bones will provide a more nearly complete skeleton of an individual than any previously obtained.

Skeletons of mastodons and mammoths are not rare; in fact it is commonly stated that every marsh or nearly every marsh conceals at least one such skeleton. Nevertheless finders of similar remains are always urged to notify qualified scientific institutions, giving them the opportunity to investigate, as any find may turn out to have unexpected importance.

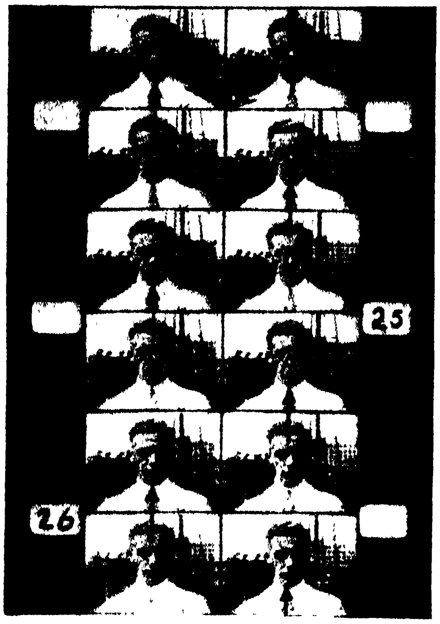
Holes in Submarines Patched Under Water

A NEW device for quickly patching holes in disabled submarines under water has been tested by United States Navy officials and pronounced successful. The device looks something like a pneumatic hammer, but employs charges of high explosive to drive steel studs through the shell of the sunken vessel, fastening an emergency patch over the rent. It is the invention of Robert Temple, of Denver.

The advantages claimed for the new submarine patcher are great speed in emergency operations, and ease of handling under water. The method now in use requires a comparatively slow-working air drill, dragging many feet of cumbersome hose behind it. The new tool drives a steel stud, three and one half inches by one half inch, through a half-inch steel plate at a single blow. It makes no noise, and complete safety for the operator is claimed.

In a navy yard test, a torpedo flask with a hole ten inches in diameter in its side was lowered into the water. A diver went down with a submarine patcher and a steel plate big enough to cover the hole. He fastened the plate in place with eight studs in about 90 seconds.

Further possible emergency uses for the new tool have been pointed out. It is possible to drive hollow studs as well as solid ones with it, and through such tubes water, liquid foods, and air could be supplied to men trapped within disabled submarines. The ends of threaded studs could be secured with nuts, thus making it possible to attach lifting cables at exactly the points desired by the commander of a salvage crew.—*Science Service.*



To illustrate how cheaper amateur movies are made—enlarged film

Cheaper Amateur Movies

A ROLL of 16-millimeter film, such as is used in standard amateur motion picture cameras, costs six dollars for a length of 100 feet which, when projected, gives a screen picture of only four minutes. A similar roll of film used in a new camera, the Homovie, which was recently announced by the Kodel Electric and Manufacturing Company, will give 16 minutes of pictures when projected in the Homovie projector. Besides this lower cost, the Homovie equipment has the advantage of eliminating frequent loading of the camera.

With the new camera, four picture images are made in each "frame" where only one picture is made with other cameras These are taken in a sequence that will give a cross-wise projection as well as a lengthwise projection. The sequence of the quarter "frames" are: forward, to the left, forward, to the right, and repeat. This is best shown by the accompanying illustration.

Since it is obvious that with a unit length of, say 100 feet, of standard 16-millimeter film, four times as many pictures may be made when using Homovie equipment as may be made with old style amateur movie cameras, it will be seen that the new equipment reduces the cost of amateur movies 75 percent.

Electric Cableway Spans Western Canyon

HIGH up in the western mountains, near the little town of Camino, California, the largest electric cableway in this country spans a canyon a half-mile wide. This cableway, recently completed for the Michigan California Lumber Company, carries lumber from a loading point on one side to the mill on the other. Because of the heavy weights, high speed, and long distance involved, the installation is one of the most outstanding of its type.

The cableway is operated by electricity, complete equipment for the purpose being supplied by the General Electric Company. A single loaded carrier, carrying a rail car loaded with a maximum of 24,000 pounds of sawed lumber—a maximum gross weight of 29 tons—passes to and fro between the two loading terminals on opposite sides of the canyon. The distance between terminals is approximately 2700 feet, the depth of the canyon is 1200 feet, and the maximum speed of operation is 1800 feet per minute, or a little over 20 miles per hour. The carrier makes a round trip in something over six minutes, including the three and one third minutes required for loading and unloading. The equipment is capable of handling this cycle continuously.

View from receiving and control building showing aerial tramway cable carrying a heavily laden car

Four steel cables, each two inches in diameter, support the carrier which runs on 32 wheels. The traction rope is endless and is one inch in diameter.

The electric equipment consists, principally of two 225-horsepower, wound-rotor, intermittent duty, hoist motors, operating mechanically and electrically in parallel, and controlled through suitable primary and secondary magnetic contactor panels. A single manually operated master controller governs both motors. The two motors are geared to two large sheaves, each eight feet in diameter, which engage the traction rope. Each motor is equipped with a motor-mounted brake. Momentarily the two motors are able to exert a combined output of 800 horsepower and, for short periods, most of this capacity is required.

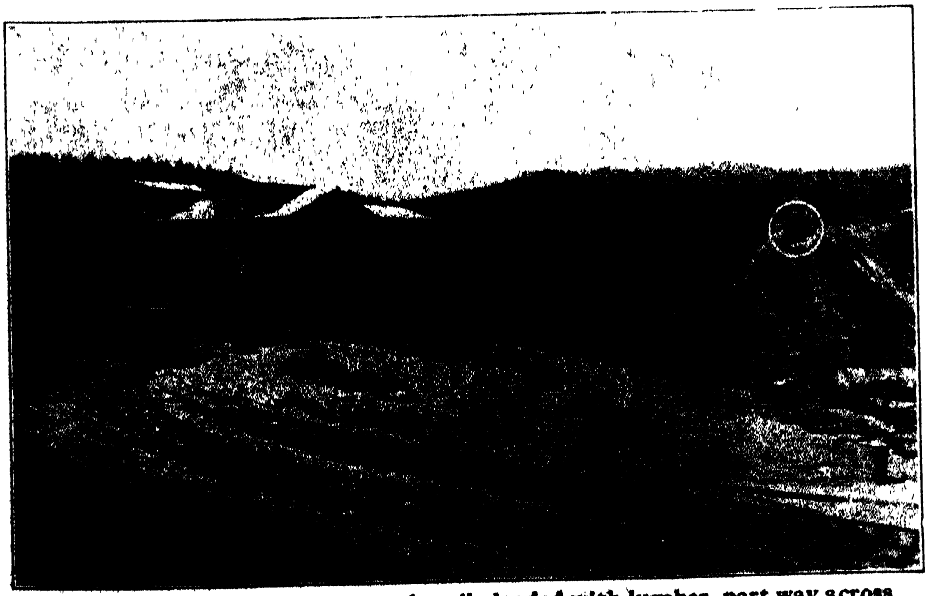
Stopping the carrier at either terminal is normally accomplished automatically, in four graded steps, by means of a geared limit switch. After being so stopped at either end, the carrier is brought to the final position. This requires accurate spotting, in order to roll off the loaded rail car, and the final spotting is done by an operator located at each terminal, through the use of an "inching" push button.

Demonstrating the new cathode-ray television set with which large audiences may be entertained

The motors and power plant are located at one side only of the canyon, and the carrier is started and accelerated by the operator at the main master switch located on the motor or power side of the canyon. The necessity for inching the load to its final position on either side of the canyon by operators located on either side, 2700 feet apart, made it necessary to provide for the transfer of control back and forth across the canyon, with a red and green signal light system and proper interlocking of control circuits for safety reasons.

The entire equipment operates under both overhauling and motoring loads at different times during the cycle of operation. For example, as the 29-ton loaded carrier descends into the sag of the supporting cables—approximately 135 feet at the middle of the span—the motors act as generators for the purpose of limiting speed. At other times, when ascending into the terminals, maximum motoring power is required.

The cableway is also used, on occasion, as a man carrier, as it is often necessary to transport men across the canyon during operations.



Aerial cable tramway with a car, heavily loaded with lumber, part way across the valley. General view showing receiving terminal building and tramway

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Cathode-Ray Television Receiver Developed

TELEVISION which can be viewed by a room full of spectators rather than by only one or two, was announced recently by Dr. Valdimir Zworykin, research engineer of the Westinghouse Electric and Manufacturing Company. The use of a cathode-ray tube as a receiver gives this new type of television many advantages over the well-known scanning-disk method of visual broadcasting.

The cathode-ray television receiver has no moving parts, making it more easily usable by the rank and file of the radio audience. It is quiet in operation, and synchronization of transmitter and receiver is accomplished easily even when using a single radio channel.

Another advantage is that, using a fluorescent screen, the persistence of the eye's vision is aided and it is possible to reduce the number of pictures shown each second without noticeable flickering. This in turn allows a greater number of scanning lines and results in the picture being produced in greater detail without increasing the width of the radio channel.

Dr. Zworykin and his cathode-ray tube used in a television receiver

The apparatus described by Dr. Zworykin is now being used in experimental form in the research laboratories in East Pittsburgh. A number of similar receivers are being constructed in order to give the system a thorough field test through station KDKA, which already is operating a daily television broadcast schedule with the scanning-disk type of transmission.

The pictures formed by the cathode-ray receiver are four by five inches in size. They can be made larger or brighter by increasing the voltage used in the receiver.

Dr Zworykin developed an entirely new type of cathode-ray tube for his receiving apparatus which he calls a "kinescope." In this tube a pencil of electrons is bombarding a screen of fluorescent material. The pencil follows the movement of the scanning light beam in the transmitter while its intensity is regulated by the strength of the impulses received from the transmitter. The movement of the scanning beam—consequently of the cathode-ray pencil itself—are so rapid that the eye receives a perfect impression of a continuous miniature motion picture.

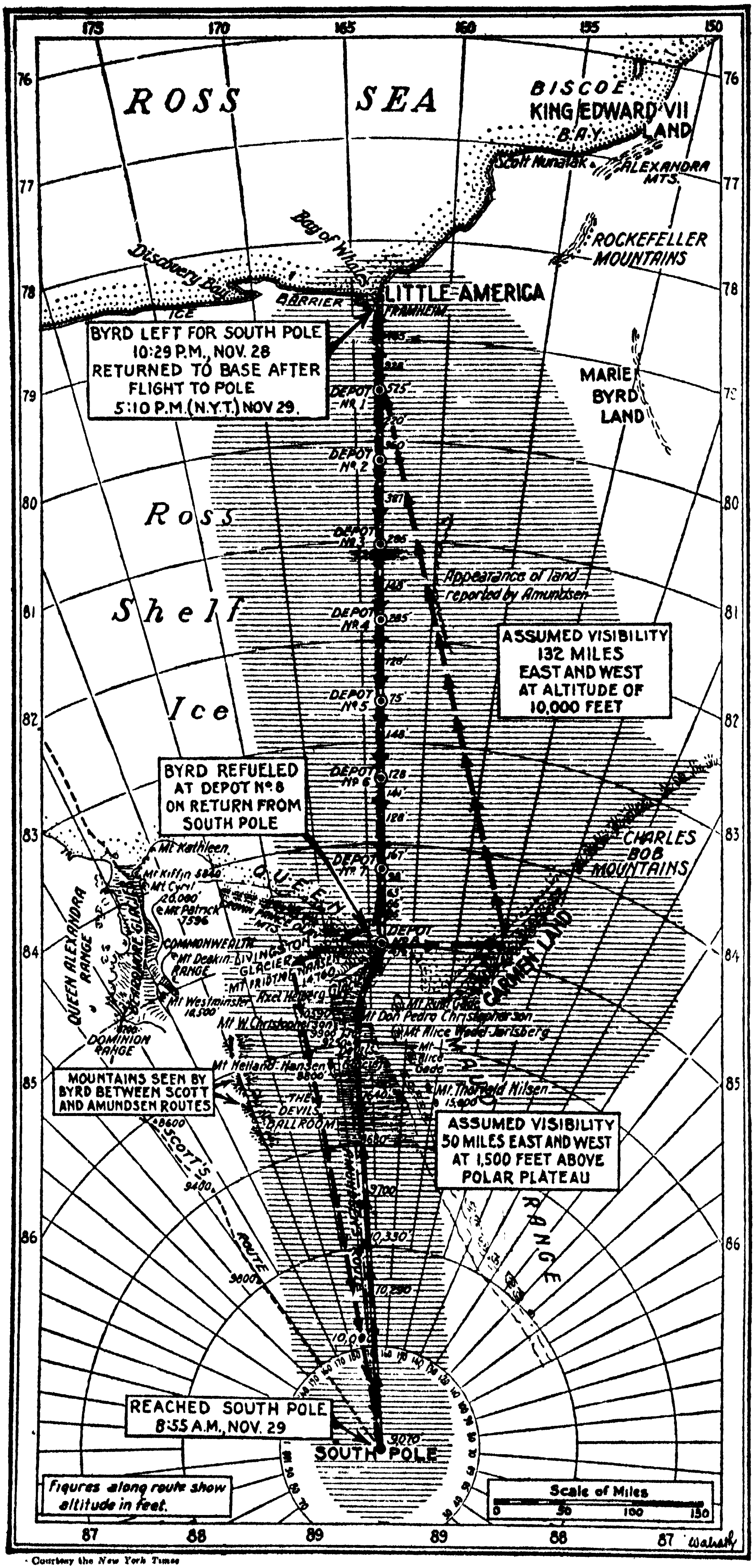
A reflecting mirror mounted on the receiver permits the picture to be observed by a number of spectators.

This condensed description of the methods used by Dr. Zworykin to effect television transmission can give only an idea of the possibilities of the new system. To the radio public it means, when perfected, a means of television which will be simple to operate because it has no scanning disk or other moving mechanical part. The receiver will operate in silence, offering no interference to sound broadcasts.

To the radio engineer the invention is important for the same reasons and because it will not be wasteful of radio wavebands. This is because the transmitter and receiver can be synchronized using but one channel.

Mice Have Hereditary Twisted Noses

TWISTED noses "run in the family" of a strain of house mice discovered by Dr. Clyde E. Keeler of the Harvard Medical School and reported to the National Academy of Sciences, Washington. He found, upon dissecting some of the speci-



Courtesy the New York Times

After over a year of preparation, during which his expedition had been in constant touch with the world by radio, Commander Byrd, accompanied by Bernt Balchen, Harold June, and Captain Ashley McKinley, made a successful flight from Little America to the South Pole, November 28-29, 1929, over the route shown. He is continuing his explorations of the Antarctic

mens, that the peculiarity is due to the shortening of one of the nasal bones, while the other bone grows to normal length. He mated one of the apparently normal brothers of a twist-nosed mouse to a normal wild mouse, and among the offspring found one with a twisted nose; but it slewed to the right instead of to the left as in the original find. This "left-nosed" mouse, paired with an apparently normal litter mate, produced one male offspring with a straight but notably short nose. Upon examination it was found that both of its nasal bones were shortened.—*Science Service.*

Russia Makes Syrup Out of Watermelons

WATERMELONS instead of cane will be the raw material used in a new syrup factory recently established at Stalingrad, fromerly Tzaritzin, on the Volga. The product, known as "nardek" has long been made by a crude hand process, and is so popular that bee-keeping has practically disappeared from the region where it is used. The better grades of the syrup are used in cooking or confectionery, and the poorer grades in the manufacture of alcohol.—*Science Service.*

What Byrd's South Polar Flight Means

IN a special message to the *New York Times* relative to Commander Richard E. Byrd's notable flight to the South Pole from Little America, and return, on Thanksgiving Day, November 28, 1929, the National Geographic Society forecasts many valuable results.

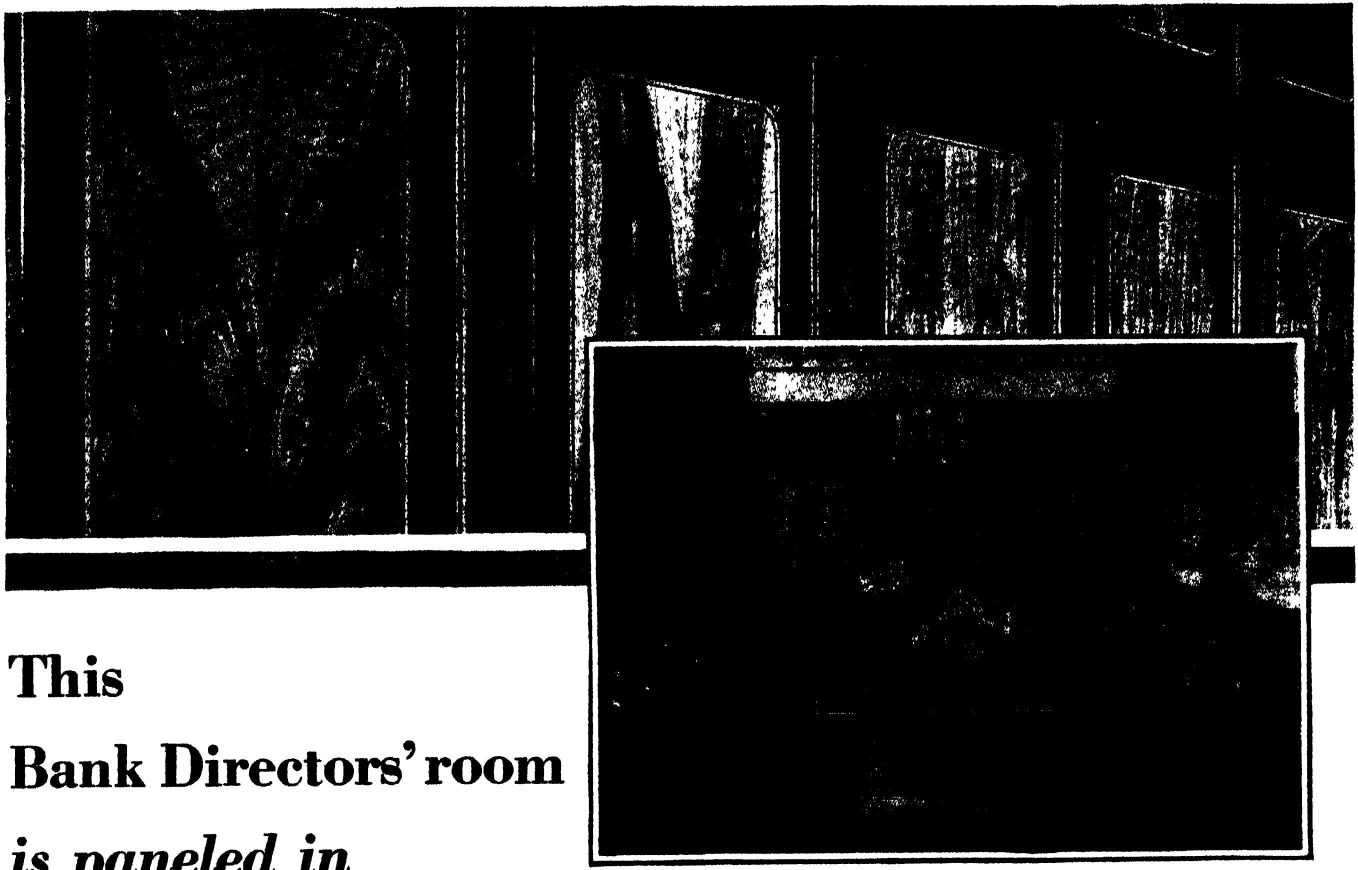
"Data gathered by the Byrd expedition will doubtless fill in many blank spots in regard to the Antarctic continent," said the message. "This will be most evident, perhaps, cartographically. From the mosaic maps made photographically from the plane during the dash to the pole, it will be possible to prepare maps in considerable detail definitely tieing the previously known areas of the southern hemisphere to the South Pole.

"To aeronautics, the expedition has already added much needed data in regard to the operation of airplanes and the behavior of metals and lubricants under conditions of extreme natural cold. Additional data in this connection was doubtless obtained on the final dash to and from the pole.

"Careful meteorological observations have been carried on by the expedition during its long stay at Little America, its sled trips and supplemental flights, and on the polar flight itself. Antarctica has been looked upon as a weather breeder for South America, South Africa, New Zealand, and Australia, and in a sense for the entire southern hemisphere. The detailed meteorological data to be brought back by the expedition may make possible more accuate weather forecasting for the whole world.

"In the radio field Commander Byrd has made history. He is the only man to have sent radio messages from both the North Pole and the South Pole. Throughout the stay of the party at Little America, radio conditions have been closely studied, and it is probable that the data collected may lead to the solution of stubborn scientific problems."

Since the above was written, Byrd has been made a Rear Admiral, retired.



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Presdwood is used in hundreds of products. Its smooth surface takes any finish. Its minutely fibrous character effects a perfect bond with either paint or lacquer. Its hardness and strength make the completed article almost immune from hair-line finish cracks.

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Presdwood is used in everything from tiny toys to motor truck bodies. It panels ice boxes and builds incubators. It makes strong specialty shipping containers for fragile articles, smooth packing cases for delicate silks. It fashions decks of fast hydroplanes; makes weather-resisting road signs, strong partitions and light shelving.

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Junkers "G-38"

QUITE recently the Junkers *G-38* made a successful trial flight at Dessau, Germany, flying for half an hour at an altitude of 1500 feet. The *G-38* is undoubtedly one of the largest land planes ever built, and it shows two distinct tendencies which are apparently in the minds of airplane constructors all the world over—increase in size and the gradual evolution of the airplane to the simplicity of a flying wing.

Exact performance data are not available as yet. It is quite clear, however, that the *G-38* is intended to carry 40 passengers (and *not* 100 as reported in some papers) with a fairly long range, is powered with four engines of 600 horsepower each, and has a wing spread of 137 feet.

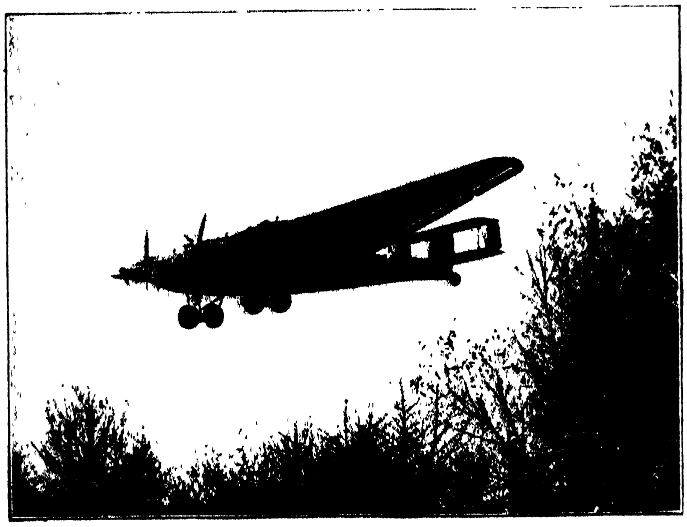
The wing construction is of the usual Junkers type; that is, braced entirely inside the wing, and tapering from root to chord, so that the wing is deepest and strongest at the root where the main stresses are to be found. With an increase in size of the wing, it is naturally possible to approach the ideal of the "flying wing." The depth of the wing at the root is between three and four feet. This allows the 12-cylinder engine, with two banks of six cylinders in V-form, to be entirely enclosed, with the only projection in the form of a streamline boss which covers the extended shaft to the propellers. Also, with the increase in size of the wing, the depth of the wing becomes an important fraction of the fuselage depth. Eventually, the fuselage will merge into the wing, or the wing merge into the fuselage, whichever way you wish to look at it.

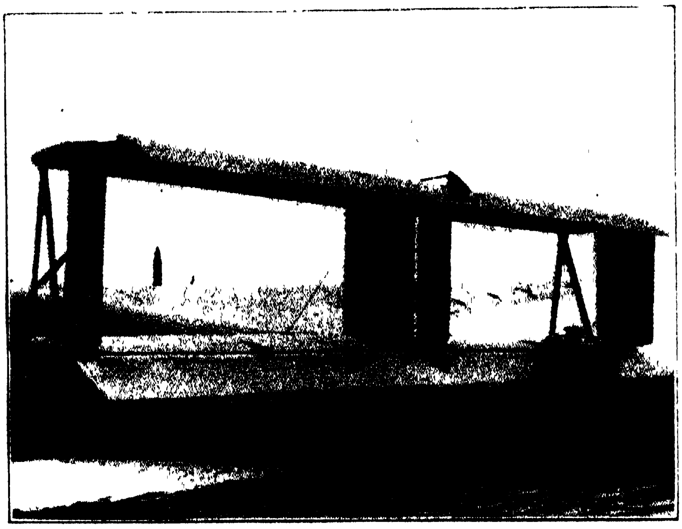
American experience has shown that when a propeller is mounted ahead of the leading edge of a thick wing, it is blanketed and loses much of its efficiency. This undoubtedly explains why the propeller shaft has been extended so far forward in the Junkers' planes.

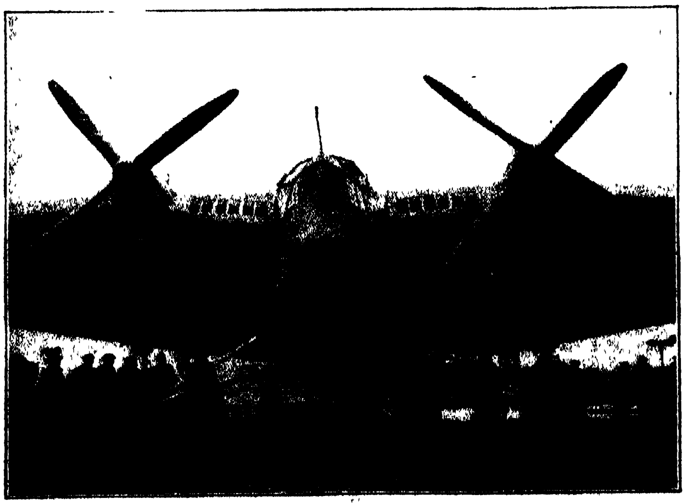
Looking at the photograph of the *G-38* in flight, we note that the two inboard propellers are four-bladed, and the two outboard propellers are two-bladed. Since four-bladed propellers are less efficient than two-bladed propellers, it may be asked why this combination has been adopted. The reason probably is that a four-bladed "prop" needs less diameter for a given horsepower and this allows the propellers to be brought a trifle closer to the center line of the airplane.

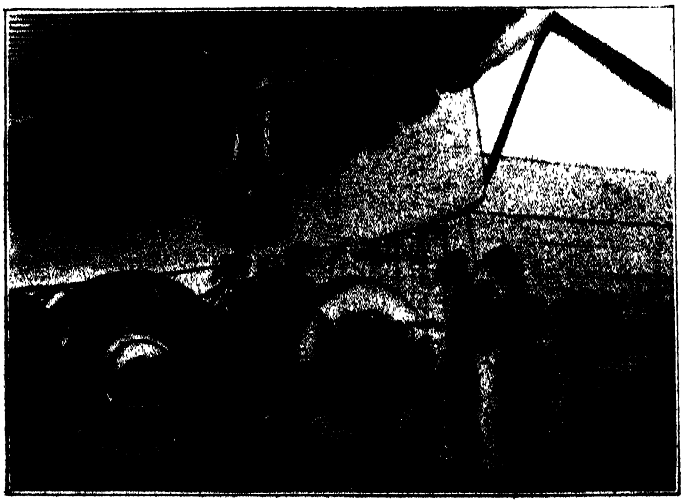
The front view of the *G-38* shows that there are two radiators for each engine, mounted under the wing and capable of being drawn into the wing when less cooling is required. There is one great advantage to the use of water-cooled engines for large planes as compared with air-cooled engines. On very large machines, the water-cooled engine can be housed so as to leave the airfoil undisturbed. This would obviously be impossible with air-cooled engines.

As planes increase in size, the question arises as to whether the pilot will have enough strength to operate the controls. Naturally the airplane constructor wants to stave off as long as possible the day when he must use servo motors, either hydraulic or electric, to operate the controls, since this means increase in cost and complexity.



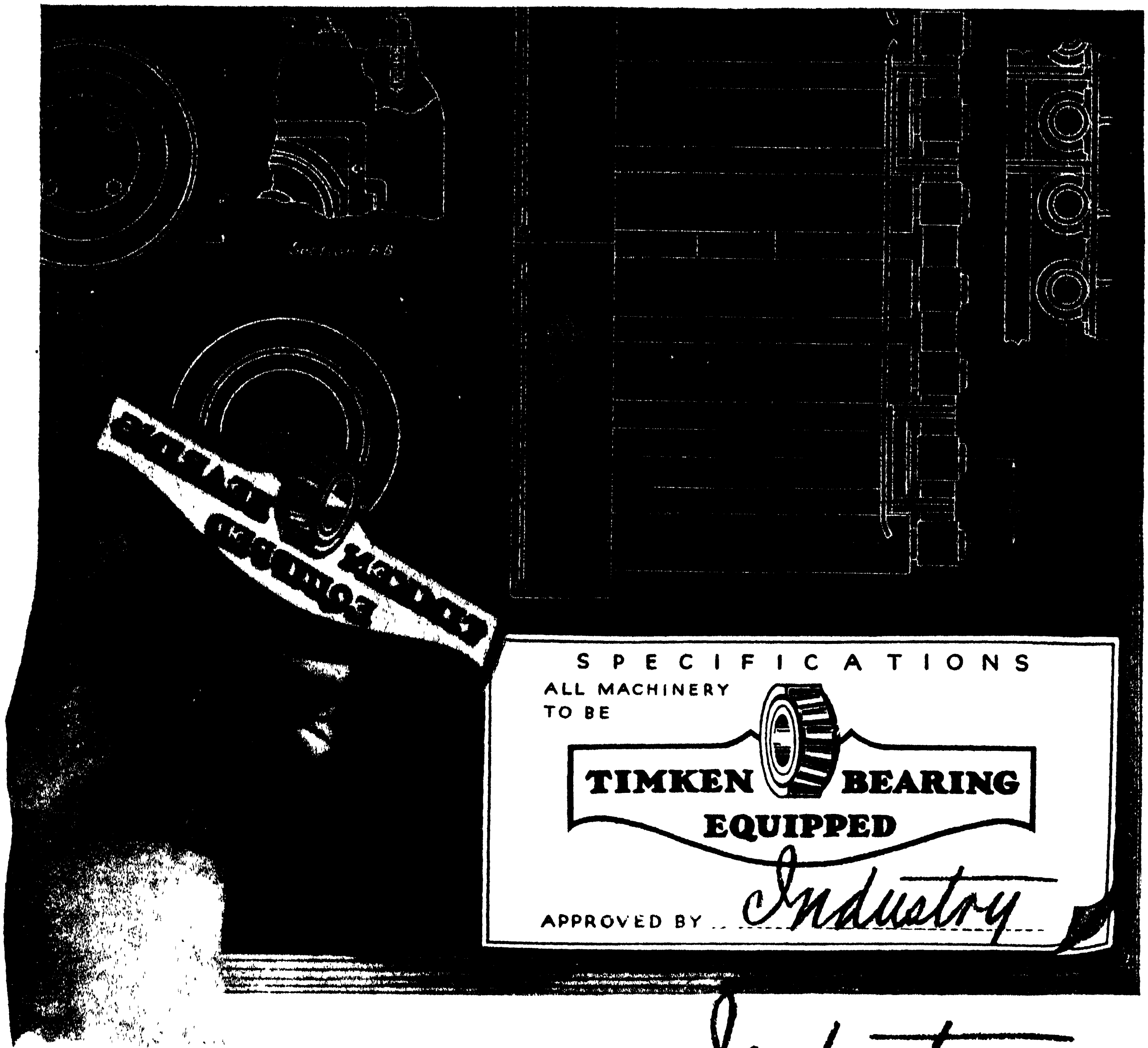






Upper left; **The Junkers *G-38* in flight.** *Upper right:* **The tail surfaces are as large as the wings of a small plane**

Lower left: **Front view, showing the radiators.** *Lower right:* **Wheel-connecting truss is hinged in the middle**



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TIMKEN *Tapered Roller* **BEARINGS**

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The way to avoid this undesirable contingency is to pay more and more attention to the balancing of the control surfaces. The ailerons of the Junkers *G-38* are hinged on points well behind the leading edge of the ailerons, the hinge points being supported by a series of arms mounted at the rear of the wing structure proper, and above the aileron. There is also a pronounced slot between the wing and the ailerons, which helps to reduce the turning moment of the ailerons and to improve their effectiveness at slow plane speeds. Both the elevators and the central rudder seem to be balanced in the same way as the ailerons.

Nothing illustrates the size of the *G-38* so well as the view of the tail surfaces. When compared to the size of the three men in our photograph, it can be seen that the tail surfaces are as large as the wings of many an airplane.

A "wrinkle" in design is the careful way in which the control horns are enclosed in a fairing.

There is one great advantage in multi-engined planes—the greater reliability of the power plant as a whole. In the *G-38* this reliability is further increased by the fact that the mechanics can get at the engines in flight, since these engines are enclosed in the wing. There is a small hand-operated trolley in the wing. The mechanic can climb into the wing from the fuselage and rapidly propel himself to any engine which may need attention.

MILEAGE AND TRAFFIC STATISTICS FOR PRIVATELY OPERATED AIRMAIL ROUTES WITHIN THE U. S. A., FOR YEAR ENDING JUNE 30, 1929

Month (all routes)	Length of routes, miles	Miles of service actually flown	Total weight of mails dispatched, pounds	Amount paid to contractors
July, 1928	12 021	653,883	214,572	$445,238 41
August, 1928	11 977	731,714	419,357	821 005 01
September, 1928	11,977	749,156	423,838	843,691 44
October, 1928	12,169	784,663	465,688	915,998 56
November, 1928	12 504	731,027	425,405	851,390 06
December, 1928	13 791	891,811	541,632	1,094,782 54
January, 1929	14,060	795,293	488,709	955,114 33
February, 1929	14,060	778,329	434,260	865 042.52
March, 1929	14,264	912,760	524,537	1,047,657 78
April, 1929	14,400	885,737	508,672	1,003,718 32
May, 1929	14,334	1,135,953	588,428	1 160,089 23
June, 1929	14,345	1,148,403	598,494	1,161,461.00
Totals	159,902	10 198,729	5,633,592	$11,165,189 20

The landing gear is particularly interesting. As planes get larger and larger, the question of the wheels becomes serious. Instead of having four wheels strung along the span of the machine, the designers have used two wheels in tandem on each side of the fuselage. The head-on resistance of the wheels is somewhat reduced by such an arrangement. It will be further seen from the photograph of the landing gear that the wheels are mounted at the end of a bridge-like truss, which is connected at its center to the shock-absorbing system. The truss is hinged at its center, so that the wheels can pivot about their common center, with shock-absorber cord keeping their pivoting motion within reasonable limits. This feature should be particularly useful when landing or taxying on rough ground.

European countries seem to be very slow in adopting the use of wheel brakes. In the *G-38* brakes are used, and with success. It is remarkable that the German designers still employ rubber as their sole means of shock absorption. The oleo landing gear has proved so successful in the United States, that it seems curious that the practice should not be followed in Germany.

Progress of the Year

THE American Society of Mechanical Engineers comprises some 12,000 or more members and is sponsor for a number of divisions which cover the widespread and varied field of mechanical engineering. Its aeronautic division presented at the December annual meeting of the society an authoritative report on the year's progress in aeronautics.

In the engine field there were three interesting tendencies. First: The use of ethylene glycol (Prestone) as the cooling medium instead of water. The boiling point of this chemical being so much higher than that of water, it is possible to use much higher jacket and radiator temperatures and thus reduce the size of the radiators. Second: The use of the Venturi cowl, which, placed around the air-cooled engine, reduces the air resistance of the engine considerably. Third: The increasing use of geared-down engines. The piston speed of the engine has been steadily increasing by the use of higher revolutions per minute, and this has been perhaps the main reason for the light weight per horsepower now obtainable. Unfortunately, very high revolutions per minute of the propeller do not co-ordinate well with the moderate speeds of commercial planes. Hence gearing down becomes imperative for the sake of greater propulsive efficiency.

In aerodynamics, the direction of progress has been largely in the elimination of head resistance, by the use of the Venturi cowling, retractible landing gear, fairing-in of wheels with so-called "trousers," and so on.

Another modern tendency in airplane design is to use wings of constant center of pressure. The ordinary wing has an unstable center of pressure motion. When the airplane pitches down by the nose, the center of pressure moves back and the nosing-down tendency is aggravated. When the airplane noses up, the center of pressure moves forward and the nosing-up tendency is increased. The horizontal tail surfaces are used to provide stability and to counteract the instability of the wing itself.

With the trailing edge of the main wing slightly turned up, it is possible, without much sacrifice in lift or efficiency, to secure a stable center of travel. It is then possible to reduce appreciably the area of the tail surfaces, and also to reduce the weight of the wing. If there is pronounced travel of the center of pressure, then the front spar carries most of the load at one time, and the rear spar at another time. With the constant center of pressure it is possible to make the front spar do most of the work, and to lighten the rear spar accordingly.

Another device which is receiving favorable attention is the floating-tip aileron. Here the aileron is placed beyond the tip of the wing itself, and is free to adjust itself so as to lie always in the wind. The control of the ailerons is, as usual, by lateral movement of the stick, but because the ailerons lie normally in the wind their effectiveness is not reduced at high angles of incidence of the main wing.

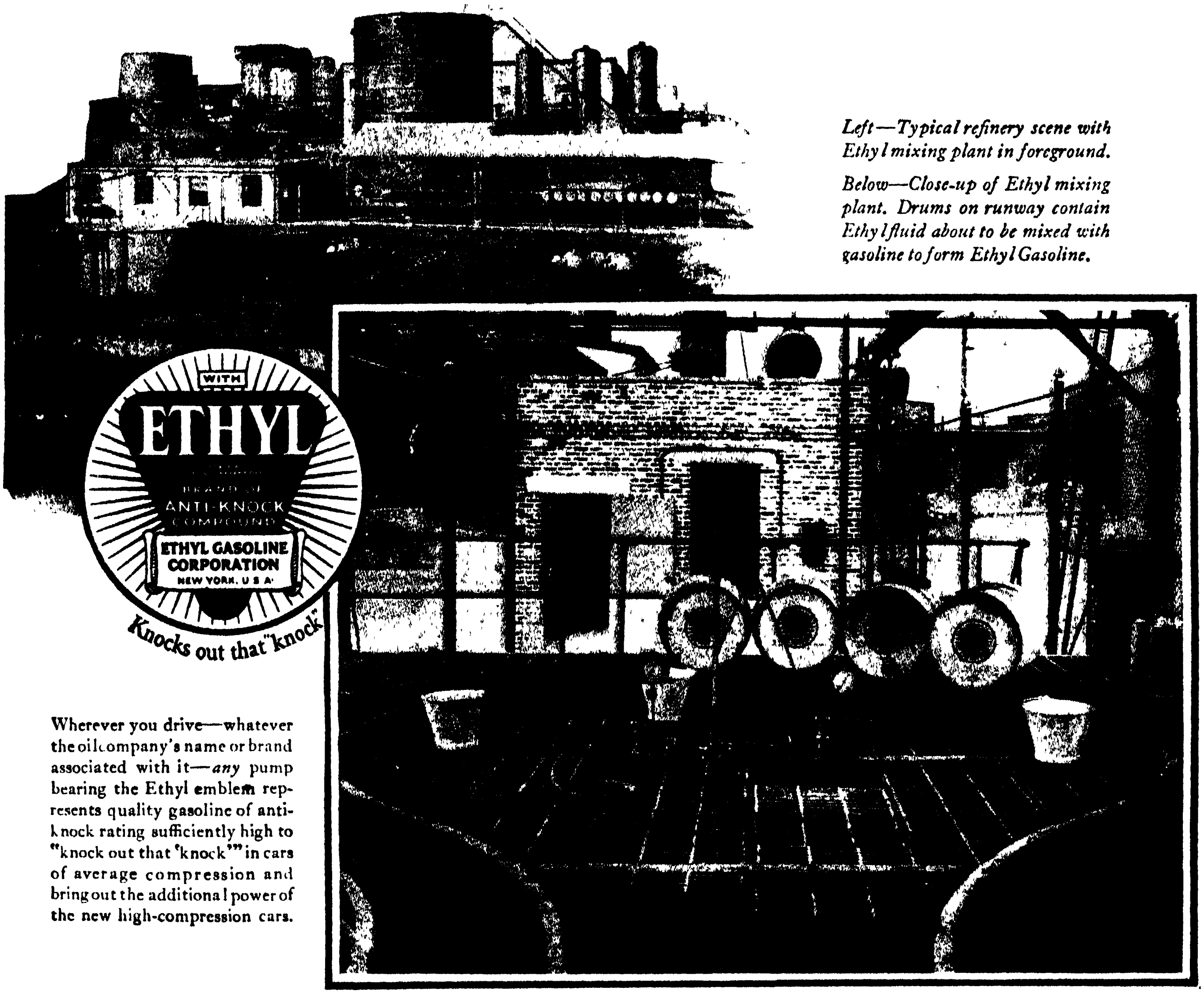
We reproduce two tables taken from the same progress report. One gives mileage and traffic statistics for privately operated mail routes. This shows a rapid and steadily growing increase in the number of miles flown and the amount of mail carried.

The other table shows that the United States now leads the world in scheduled

(*Please turn to page* 166)

AIR-TRANSPORT MILEAGE OF THE WORLD OPERATIONS OF SCHEDULED SERVICES IN AIRPLANE-MILES

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Australia				.	235,582	262 895	352,847	417,970	453,580	641,831
Austria			.	.	.			.	245,043	383,002
Belgium					. .	160,000	144,500			....
Canada				.		294,778	446,648	631,715	. . .	....
Columbia		2,687	53 650	125,678	134,375	169,500	183,206	...	....	....
Czechoslovakia						126,400	48,300	170,895	257,888	605,314
Denmark				.	56,000	. . .	114,500	126,730	116,798	122,215
France		505,500	1.460 000	2,015,000	2,115,000	2,249,000	2,946,000	3,243,900	3,755,369	3,753,133
Germany				842,986	885,881	1,860,000	3,070,000	3,816,144	5,921,593	7,030,565
Great Britain	168,000	644,000	225,000	717,000	943,000	936,000	862,000	840,000	*769,000	....
Italy	. .				. .	...	...	....	824,474	1,236,913
Mexico					.	.	....	96,800	146,400	....
Netherlands		50,850	217,000	246,200	336,000	482,800	679,753	597,500	813,510	1,007,920
Poland	. .		.	66,293	142,057	233,923	465,847	. . .	654,873	630,175
Soviet Russia	.			. .	.	288,600	292,595	311,000	....	....
Sweden	. . .		.	.	...	69,280	248,610	222,000	206,766	208,729
Switzerland	...	.			....	268,400	87,427	210,340	459,720	330,496
United States	393,066	880,028	1,828,354	2,329,296	1,743,030	2,220,761	2,910,611	4,407,263	6,009,226	9,888,307



Left—Typical refinery scene with Ethyl mixing plant in foreground.

Below—Close-up of Ethyl mixing plant. Drums on runway contain Ethyl fluid about to be mixed with gasoline to form Ethyl Gasoline.

Wherever you drive—whatever the oil company's name or brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of anti-knock rating sufficiently high to "knock out that 'knock'" in cars of average compression and bring out the additional power of the new high-compression cars.

How *Ethyl Fluid is mixed with gasoline*

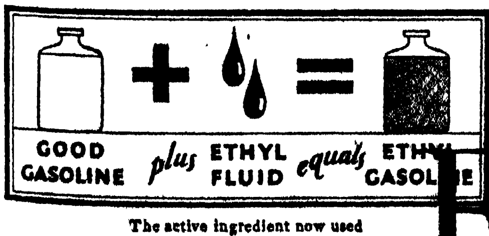
ANYONE interested in practical chemistry would enjoy a visit to one of the plants in which the oil companies mix Ethyl fluid, containing tetraethyl lead, with their gasoline to form Ethyl Gasoline.

What would probably be most impressive would be the *precision* with which it is done. Engineers from the oil company or from the Ethyl Gasoline Corporation supervise every step of the process.

First, the base gasoline with which Ethyl fluid is to be mixed is tested at an Ethyl laboratory. From this test, the exact amount of Ethyl fluid necessary to bring the gasoline up to a rigid standard of anti-knock quality is determined. An accurate measuring device is used at each refinery to insure that this quantity of Ethyl fluid goes into every gallon of gasoline.

Look for the Ethyl emblem.

Ethyl Gasoline Corporation, New York City.



The active ingredient now used in Ethyl fluid is tetraethyl lead.

©E. G. C. 1930

ETHYL GASOLINE

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Aeronautics

Aviation (Facts that Every Aviation and Financial Official Will Want to Know) tells about the efforts of the Better Business Bureau of New York City to apprehend and prevent fraudulent aviation promotion schemes. *Better Business Bureau, 280 Broadway, New York City—Gratis.*

Airplane Fuselage Welding and How To Weld Duralumin are two papers presented in one leaflet. The first is an outline course for welders engaged in aircraft construction; the second describes correct practices for making ox-welded joints in aluminum alloys. *Linde Air Products Company, 30 East 42 Street, New York City—Gratis.*

Sinister Beacons, a booklet dealing with fire hazards of airports and landing fields, lists recommended fire fighting materials and apparatus. *American-La France and Foamite Corporation, Elmira, New York—Gratis.*

Electricity

Protection of Electrical Circuits and Equipment Against Lightning (Bureau of Standards Miscellaneous Publication No. 95) tells how and where lightning arresters should be installed in those cases where it has been decided that their use is justified. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents.*

Short-Wave Transatlantic Radio-Telephony, reprinted from the *Bell Laboratories Record*, is an interesting booklet presenting 12 papers which tell the various stages of the development of the two-way transatlantic telephone service over short-wave paths initiated by the American Telephone and Telegraph Company in 1928. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

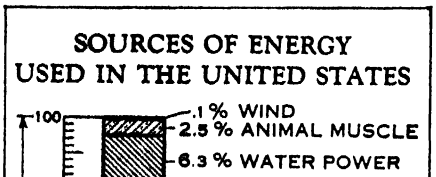
Some Universal Principles of Communication, by John Mills, is an outline of the fundamentals of communication, and the relationship of telephony, telegraphy, sound pictures, and television. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

Lighting Data, a series of booklets published by the Edison Lamp Works, includes the following new titles:
Looking Ahead in Aviation; Floodlighting; Electric Light on the Farm and in Rural Districts; and Luminous Harmony in the Home. All of these booklets are well illustrated and written in non-technical language, presenting valuable information and practical suggestions. *Edison Lamp Works, General Electric Company, Harrison, New Jersey—Gratis.*

Analysis and Measurement of the Noise Emitted by Machinery, by B. A. G. Churcher and A. J. King, is an engineering study of noise, based on an extended investigation now being conducted by the Metropolitan-Vickers Electrical Company, Ltd., *Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W. C. 2, England—Inquire cost.*

Miscellaneous

Shift of Civilization Chart and Manual, by Samuel S. Wyer, is a striking presentation of the most significant steps in the development of science, religion, and law from man's beginning to the present day. *Fuel-Power-Transportation Educational Foundation, 1116 Beggs Building, Columbus, Ohio—Gratis.*



Self-explanatory diagram from the "Shift of Civilization Chart and Manual" mentioned in the text

General Catalog illustrates and lists natural history materials collected and made available to educational institutions by the Frank A. Ward Foundation of the University of Rochester. The materials listed cover the fields of human anatomy, comparative anatomy, zoology, entomology, paleontology, geology, and minerology. *Ward's Natural Science Establishment, Inc., P. O. Box 24, Beechwood Station, Rochester, New York—75 cents.*

Vitamins in Food Materials, by Sybil L. Smith, (Circular No. 84, Department of Agriculture) is a complete review of the authenticated data available concerning the various vitamins and their occurrence in food materials. More than half of the circular is devoted to bibliographies, showing references dealing with vitamin occurrence in each food. The references also cover the techinique for the quantitative determination of vitamins. *Superintendent of Documents, Washington, D. C.— 15 cents.*

Annual Report of the Smithsonian Institution (1928) is distinguished by its 600-page General Appendix, containing 27 outstanding papers written by leading scientists on a wide variety of topics. *Superintendent of Documents, Government Printing Office, Washington, D. C.—Two dollars (cloth binding).*

Dam or Bridge: Which? Under this title, Mr. Cyrus C. Walker presents a well-prepared plan for converting the interior part of San Francisco bay into an enormous fresh-water lake, by constructing an earthen causeway from a point near Van Ness Avenue on the San Francisco shore to Tiburon on the Marin County shore, including Alcatraz and Angel Islands. The plan is suggested as an alternative for the proposed bridge across the Golden Gate. *C. C. Walker, 230 Upper Terrace, San Francisco, California —50 cents.*

The Duke Endowment Year Book is an interesting description of the charities promoted by the bequests of the late James B. Duke. The millions of dollars accumulated by the tobacco and power interests of the Duke family are being returned gradually by means of well-directed philanthropies to universities, hospitals, orphanages, and rural churches. *The Duke Endowment, Power Building, Charlotte, N. C.—Gratis.*

Silver Solders is a new booklet describing the specifications and uses of various silver-alloy solders, with suggestions and instructions for correct soldering practice. *Handy and Harmon, 57 William Street, Bridgeport, Conn.—Gratis.*

Spontaneous Combustion of Hay, by Dr. Charles A. Browne of the Bureau of Chemistry and Soils, presents the various theories of spontaneous combustion, summarizing the present knowledge of the subject. Dr. Browne adds a theory of his own, while pointing out the need for more study of the problem. *United States Government Printing Office, Washington, D. C.—10 cents.*

THE TELEPHONE BRINGS THE ADVANTAGES THAT COMFORT AND CONVENIENCE GIVE TO LIVING

This is the telephone's mission

An Advertisement of the American Telephone and Telegraph Company

In this country, a new type of civilization is being reared—a civilization of better opportunity for the average man, comfort and convenience, business enterprise and higher standards that enrich the daily life of all the people.

To build for this new age, the Bell System in 1929 expended more than 550 million dollars. These millions were used to add new plant and further improve service. Hundreds of new buildings, millions of miles of wire, chiefly in cable, eight hundred thousand new telephones—these were some of the items in the year's program of construction. At the same time, better records were made for speed and accuracy in service.

This American development of instantaneous communication, of fast, far-reaching speech, belongs not to the few, but to the many.

It is the aim of the Bell System to permit each personality to express itself without regard to distance.

This is part of the telephone ideal that anyone, anywhere, shall be able to talk quickly and at reasonable cost with anyone, anywhere else. There is no standing still in the Bell System.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Baking Powder Leaves No Traces in Bread

A NEW baking powder that leaves no undesirable traces in the bread is proposed by Edwin O. Wig in a recent issue of *Industrial and Engineering Chemistry*. Mr. Wig has investigated the properties of acetonedicarboxylic acid and finds it possesses many qualities which recommend it as a leavening agent.

Authorities disagree as to the physiological action of the products left by baking powders in baked goods. Inasmuch as all common baking powders leave saline cathartics, such as sodium tartrate, Rochelle salt, disodium acid phosphate, or sodium sulfate, and since there is some question as to the physiological effect of aluminum hydroxide, a leavening agent that would leave no residue would preclude the possibility of any controversy and would constitute an ideal baking powder.

Acetonedicarboxylic acid was prepared by adding fuming sulfuric acid to citric acid The resulting acetonedicarboxylic acid was crystallized from ethyl acetate several times and then dried over calcium chloride. Cornstarch or other starch was dried by heating under reduced pressure in a flask on a steam bath. Starch and acetonedicarboxylic acid were then weighed and mixed so as to give a baking powder which would yield from 13 to 15 percent carbon dioxide, the usual strength of a commercial baking powder.

Cakes, and in one case, bread, were baked, some with a commercial baking powder and some with acetonedicarboxylic acid baking powder. The same recipes were used and the same oven conditions, the two products generally being baked side by side. In every case the acetonedicarboxylic acid powder raised the product as well as the commercial powder.

The investigator is convinced that an acetonedicarboxylic acid baking powder might be manufactured to compete with the more expensive baking powders on the market, especially if cheaper citric acid were made available. Such a powder would have the advantage of leaving nothing in the baked product.

Removing Calcium Sulfate Deposits from Pipes

IN hot water containing sulfates, the presence of even a small amount of lime will cause the precipitation of insoluble calcium sulfate. When pipe lines or integral parts become sufficiently coated to retard circulation, the removal of the deposit becomes an important problem. Calcium sulfate is not soluble in the usual solvents. Chemists of the United States Bureau of Mines have determined that a hot solution of bicarbonate of soda will react with calcium sulfate to form a loose mixture which permits the removal of the bulk of the scales by the current flow of the solution. The remaining scale is sufficiently changed so that a weak solution of hydrochloric acid will completely remove it from the line.

Catalysis Reduces Cost of Acid

ONE of the first things learned by the student in chemistry is that an acid is neutralized by an alkali—in other words, sulfuric acid and ammonia, for example, are at opposite ends of a scale and when they are brought together they destroy each other's identity as completely as Eugene Fields' Gingham Dog and Calico Cat:

"But the truth about that cat and pup—
Is this—they ate each other up!"

With this basic knowledge of the behavior of acids and alkalies, one would hardly expect an acid to be made by the use of an alkali. Yet this very procedure is finding extensive application in the manufacture of sulfuric acid, where modern chemistry has developed a process of transforming ammonia into the nitric oxides required for the formation of H_2SO_4 in lead chamber plants. Where formerly about three and one half percent of all the nitrate imported from Chile was used to supply nitric oxides in sulfuric acid plants, American manufacturers are now freed from this dependence on a foreign source and enabled to produce cheaper acid by the substitution of ammonia—a by-product of coke manufacture.

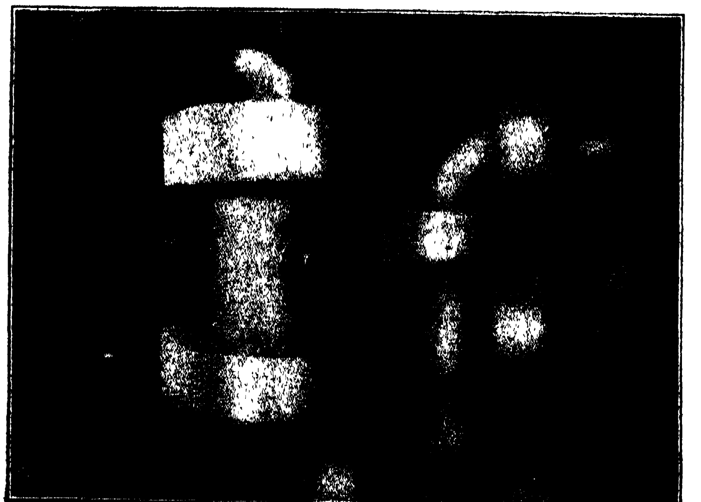
This process of oxidizing ammonia has been developed by the Du Pont Company and is similar to the Du Pont process for the production of nitric acid from ammonia. It is fully described by T. R. Olive in a recent issue of *Chemical and Metallurgical Engineering*. The most interesting feature of the installation, from the technical point of view, is its compact form and its automatic operation. The automatic gas analyzer, known as Ranarex, shows exactly what percentage of ammonia is being supplied to the system and another ingenious "robot," the Smoot regulator, adjusts the valve to keep the gas flow just right.

Ammonia gas, mixed with air, is filtered, heated to about 250 degrees, Centigrade, and passed through a converter, which contains a platinum-rhodium alloy gauze. Passing through this gauze, the ammonia is converted by catalysis into oxides of nitrogen. The reaction gives off heat which keeps the wire gauze at a cherry red heat. The surplus heat is also used to pre-heat the ammonia mixture entering the converter, by means of a heat-exchanger. Some of the remaining heat in the converted gas is utilized to vaporize the anhydrous ammonia which is used as raw material. The cooled gas is then delivered directly into the sulfuric acid plant, where the oxides of nitrogen play their vital part in the formation of that universally important chemical.

Different Dynamites for Specific Uses

WHEN Alfred Nobel began making dynamite on a commercial scale in 1865, the product was used for quarrying, submarine blasting, mining, and construction work Since then, successive chemists have so improved this useful explosive that it is now almost fool-proof

One of the oxidation units of the sulfuric acid plant of the Davison Chemical Company, showing pressure gage, flow meter, and automatic ammonia gas tester



Close up, showing the converter and heat exchanger manifold. Through the sight glass in the converter, one may see the red hot platinum gauze catalyst and there are dozens of different varieties made especially for specific uses. There is even one type, 90 percent gelatin, which is suitable or economical for any other work.

The high grades of straight dynamite, says Arthur LaMotte in a recent issue of *Chemical and Metallurgical Engineering*, have been found admirably adapted for blowing ditches in swamp land by what is known as the propagation method. They also are suitable for mudcapping boulders and rocks in quarry work, but these explosives are not suitable for use in the main boreholes in quarry blasting or in underground work. Medium-grade gelatins, 40, 50, and 60 percent, are admirably adapted for underground work in metal mining and hard-rock tunneling, but are not suitable for mudcapping or ditching by the propagation method, or for coal mining. Ammonia dynamites are used extensively in mining rock salt, gypsum, clay, and some of the more friable metallic ores, but cannot, of course, be used in submarine work or for ditching by the propagation method.

Waltzing Mice Detect Poison Gas

JAPANESE waltzing mice have been found to be more responsive to concentrations of the deadly carbon monoxide than canaries, long used by the United States Bureau of Mines for this purpose in connection with mine rescue operations. On the other hand, guinea pigs have been found to be unsuited for detecting dangerous amounts of carbon monoxide.

Due to their almost incessant activity, Japanese waltzing mice are more susceptible to carbon monoxide than either canaries, common house mice, or white mice. The Japanese waltzing mouse is thought to be a mutation of the house mouse and is commonly found in Japan and China. They appear to be unable to orient themselves in a horizontal plane, which results in an erratic running in circles—sometimes wide, sometimes narrow, and sometimes in pairs forming a figure eight and repeated many times in rapid succession.

In comparative tests with canaries made at the Pittsburgh Experiment Station of the Bureau of Mines, it was found that the Japanese waltzing mice showed signs of response to carbon monoxide in advance of signs in the canaries heretofore used.

Will Reveals Novel Conception of Immortality

CHEMICAL AGE reprints the following extract from the will of the late Henry A. Wadworth, a prominent and wealthy Englishman, which reveals the writer's unique conception of immortality, via chemistry:

"I believe (and some of the leading scientific men of the day assure me that I believe rightly) that at my death the organic constituents of my body will be quickly converted into carbonic acid and ammonia, and that those gases will, by the law of diffusion, be at once distributed over the whole world and will help to build other plants and in their turn animals, so that in the future every plant and animal in the world will contain an infinitesimal portion of my body.

"The inorganic parts of my body, the phosphates of lime, et cetera, will also be

(Please turn to page 163)

Ingenious Men Have Found Many Uses for This New Product

For pattern making, Plastic Wood is more durable than wax or leather.

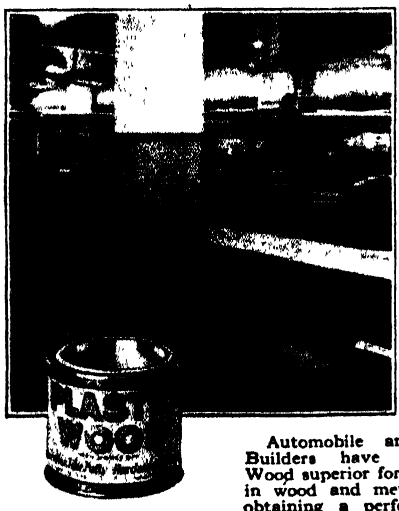
Plastic Wood, which handles like putty and hardens into wood, has been sold for home repair purposes for some four years. Recent developments in the industrial field have been most interesting.

Holes, cracks, wood blemishes, chipped mouldings—little by little as Plastic Wood made itself useful to men at home, these same men began to see its value in their factories to solve upkeep and production problems. Their ingenuity has created many time and labor saving uses for this unusual product.

No more "buttons" in this furniture factory. Plastic Wood is the modern method.

The modern pattern shop finishes patterns; the piano manufacturer fills blemishes in oak, mahogany or ebony; the furniture manufacturer has found Plastic Wood unequalled in covering counter-sunk screws; the shoe manufacturer for repairing and re-fashioning lasts.

Practical Value in Unexpected Places



Automobile and Bus Body Builders have found Plastic Wood superior for covering joints in wood and metal bodies, and obtaining a perfect finish over nails, screws and bolts.

Wherever a patching material is necessary, wherever a surface needs to be built up or re-shaped, Plastic Wood is the modern answer. It adheres lastingly to wood, metal, stone, fabric, glass or other products. It will not disintegrate, chip or splinter, can be worked with any wood-working tools, takes paint, varnish or lacquer perfectly, and is waterproof, and greaseproof. Experiments by manufacturers are daily proving its practical value in the most unexpected places. Do you know it?

PLASTIC WOOD
Trade-mark Reg. U. S. Pat. Off.

Handles Like Putty—Hardens Into Wood

Plastic Wood (and Plastic Wood Solvent for softening or thinning Plastic Wood) is regularly carried in stock by Hardware and Paint Dealers

1 lb. can $1.00—1-4 lb. can 35 cts.—Tube 25 cts.

Manufacturers and Industrial Corporations desiring information as to color, bulk sizes, or advice as to the adaptability of Plastic Wood for specific problems are invited to communicate direct with the makers.

Addison-Leslie Co., 50 Bolivar St., Canton, Mass.

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.

Editor of the Journal of the American Medical Association *and of* Hygeia

Carbon-Arc or Quartz Mercury-vapor Lights

SINCE the use of the carbon-arc and the quartz mercury lamps has become general there has been much argument as to which is more efficient, which type more suitable for the public, and which type less potential of danger. The carbon-arc lamp provides ultra-violet rays, exactly as does the quartz mercury-vapor lamp. The amount of ultra-violet rays supplied and the amount of infra-red or heat rays supplied depends, of course, on the size of the equipment, the intensity of electrical power consumed, and similar factors.

The carbon-arc lamp yields more heat rays than does the quartz mercury-vapor and should not, of course, be chosen when the heat rays are not desired. By the use of special carbons cored with materials which emit strongly in the longer visible rays and in the shorter infra-red rays, the carbon-arc lamp becomes an excellent source of heat rays. By the use of suitable screens of window glass, in fact, it is possible to screen out the ultra-violet rays entirely and thus to use the carbon-arc lamp purely as a heat lamp.

The American Diet

ONE of the most significant facts of the past 25 years has been the gradual change in the American diet. The amount of food taken is approximately 1000 calories less per day than used to be taken. The old diet consisted primarily of meat, potatoes, coffee, and sugar, whereas it is generally recognized that Americans are eating more fruit and vegetables and that they do pay some attention to the question of vitamins.

Dr. Lovell Langstroth of San Francisco tabulated the diets of 501 persons having degenerative diseases, with particular reference to the amount of protective food substances which they ate, and with a view to finding out whether or not changes in the diet could be related to the degenerative diseases. He found that non-protective foods formed 54 percent of the average diet, and that if all accessory foods were included, the non-protective foods formed 88 percent of the average diet. Bread, butter, meat, potatoes, and sweet desserts formed the great bulk of the diet of most of the people studied. With the exception of butter and cream, which contain considerable amounts of the fat-soluble vitamin A, these diets are vitamin poor.

When the patients were put on a well balanced diet calculated to provide proper amounts of protective substances, the percentage incidence of degenerative diseases decreased. Thus a diet containing 70 percent of protective foods was prescribed in 44 cases of chronic circulatory diseases, 75 cases of chronic arthritis, 55 cases of chronic gastro-intestinal diseases, and 10 cases of migraine. Doctor Langstroth reports that 73 percent of these 174 people were improved by the change in diet. There were changes in their body weight, in the appearance and feel of the skin and subcutaneous tissue, and in the quality and reactions of the mucous membranes.

In discussing Doctor Langstroth's point of view, Dr. George B. Eusterman of the Mayo Clinic pointed out that the known criteria of an efficient diet are simple. They include adequate calories to supply energy, sufficient protein of the right type, a carbohydrate-fat ratio which must fall within certain limits, adequate amounts of fluid, and sufficient fresh fruit and vegetables to safeguard the vitamin and inorganic salt intakes. Overeating of sugar or carbohydrates results usually in obesity. A persistent relative vitamin deficiency is likely to provoke bodily discomfort, impaired tone of the body, and a lowered resistance to disease.

Symptoms of Tuberculosis

INVESTIGATORS for the National Tuberculosis Association have studied the order in which the important symptoms of tuberculosis appear in various people. This is, of course, of the greatest importance, since early diagnosis and treatment are essential to recovery. Cough is the most common symptom reported; frequent colds and expectoration of a good deal of material are also quite common.

One of the leading symptoms is the fact that the person becomes tired too easily and suffers with fatigue early in the morning. Loss of weight and appetite are common in this disease. About one half of the persons examined suffered with pain in the chest. This pain is usually due to the fact that the tuberculous infection produces inflammation inside the chest and adhesions between the lungs and the chest wall. Hemorrhage from the lungs is not so common as an early symptom. The five most common symptoms of tuberculosis in the early stages are cough, being too easily tired, loss of weight, loss of appetite, and pain in the chest.

Inflammation of the Spine

THE human backbone is a most inefficient tissue. The erect carriage of the human being is an acquirement of comparatively modern times, as one considers the age of the earth, and thousands of years are required for the adaptation of tissues to a new function, rather than a single generation. The development of the X ray enabled specialists in orthopedic surgery to study the condition of the spine in a fairly simple manner. Recently Dr. L. W. Allard conducted an investigation concerning spinal inflammation among orthopedic specialists throughout the country and among industrial commissions. When the X-ray plates were examined, it was found that a considerable majority of people over 50 years of age have had at one time or another inflammations of the spinal joints, and that these show in the X-ray pictures even though they may not give any important symptoms.

The most frequent occurrence seems to be in male laborers, which Doctor Allard believes is due to the fact that they are constantly subject through their active life to infection, disturbances of digestion, strains in posture, and repeated accidents. Often a relatively minor accident, such as a sudden twist or fall, which would not affect a normal spine, will produce disability in one which has previously been subjected to infection.

Industrial commissions constantly assert that injuries of the back with disability cause them more trouble than any other type of injury which comes to their attention. Certainly a man with an old inflammation of the spine should not select an occupation which is likely to put new stresses and troubles on any tissue. The United States is not the only country which is confronted with this problem. It has been found among industrial workers abroad that there are seven times as many disabled by inflammations of the joints of rheumatic character as are disabled by tuberculosis.

The primary method of relief for such inflammations is, of course, rest of the affected tissue, with the application of heat, and other common methods of alleviation. Rest may be not only the type that is secured by being in bed, but also rest through the prevention of motion. An inflamed or painful tissue should not be moved or manipulated. The specialist in orthopedic surgery produces rest for inflamed backs by the use of braces and corsets which hold the spine immovable.

The Changing Characters of Infection

AGAIN and again it is necessary to point out that germs are living organisms and that they change their characters exactly as do human beings in response to changes in their heredity and in their environment. The matter has been brought significantly to the public attention in recent months because of reported failures of the ordinary commercial anti-meningitic serum in the case of epidemics of meningitis which have occurred in various parts of the world. Apparently the meningitis germ will change its character from time to time during the intervals between epidemics and the serum which was useful in a previous period may not act against the newer germs. This does not mean that the serum treatment is in any sense of the word to be discredited. When a serum is prepared by the injection of the germs which may be isolated from the current epidemic, it is just as effective and efficient as in previous instances.

In a recent small epidemic in a western city, involving 60 cases of the epidemic type, cerebro-spinal meningitis in ten cases was fatal. Because of the great fatality in these early cases, a different serum was obtained and this was found to give much better results. Of the 21 patients given this serum, 14 lived and seven died. Among patients who did not receive this serum, the mortality was 21 percent higher than among those receiving the special serum.

The study of the epidemic caused Dr. J. Mercer Anderson to conclude that there was a marked variation in the virulence of the meningitis germ and that the serums used varied in potency, so that it is important to determine that the specific serum is active against the specific organism. Fortunately it is possible by immunologic reactions to make such determinations promptly in any instance.

Ajinomoto

THE Japanese eat much rice and little meat Such a diet has little energy in it. Hence the Japanese add to their food a substance which has a meat flavor but which is not meat. The use of meat in the diet, as is pointed out in a recent editorial in the *Journal of the American Medical Association* is condemned by Buddists, and instead, shavings of dried fish are added to Japanese dishes to improve the flavor.

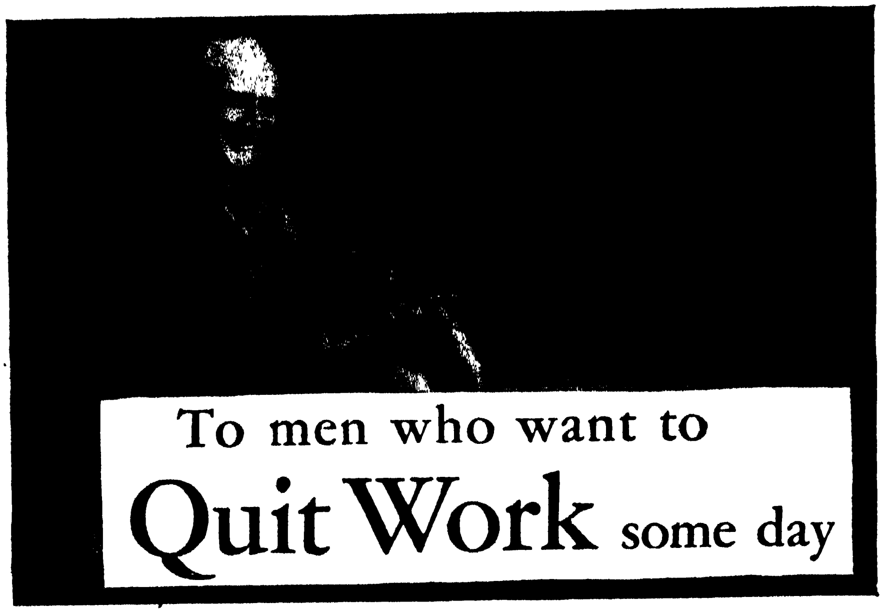
The important substance is monosodium glutamate. It is now available in commerce and is said to be as common in Japanese cookery as is salt in American cookery. This substance is called in Japan "Ajinomoto" or the element of taste. It is reported that it is manufactured by hydrolyzing gluten or soy bean with hydrochloric or sulfuric acid. In this country it costs two to three dollars a pound.

Sugar and Convulsions

WHEN changes occur in the blood, the body reacts in various manners, according to the chemical substances that may be present. If the amount of sugar in the blood is extremely low, the patient becomes confused and may develop convulsions. This has happened in some cases when an overdose of insulin has been taken Whenever this occurs, it is customary to feed quantities of sugar and orange juice to supply the deficiency, and the convulsions are promptly relieved after taking the food.

Some years ago it was suggested that convulsions in infants following a period of fasting with fever might be due to the fact that there was an insufficient amount of sugar in the blood. Fasting prevents the intake of sugar, and fever burns up sugar in the body. Dr. J. P. Crozer Griffith of Philadelphia determined to test the matter thoroughly on a group of infants and children who had been subject to convulsions. His work caused him to believe that the night fast which the child takes because it is asleep is not of importance in producing convulsions in the morning, but he is inclined to the belief that the amount of sugar in the blood does have something to do with the time of appearance of the convulsions.

There seem to be relationships here which have not been definitely established, since a low blood sugar may exist without convulsions. On the other hand, in some instances the feeding of sugar caused prompt discontinuance of the convulsions, and this factor seems to be of much greater importance in some cases than in others.



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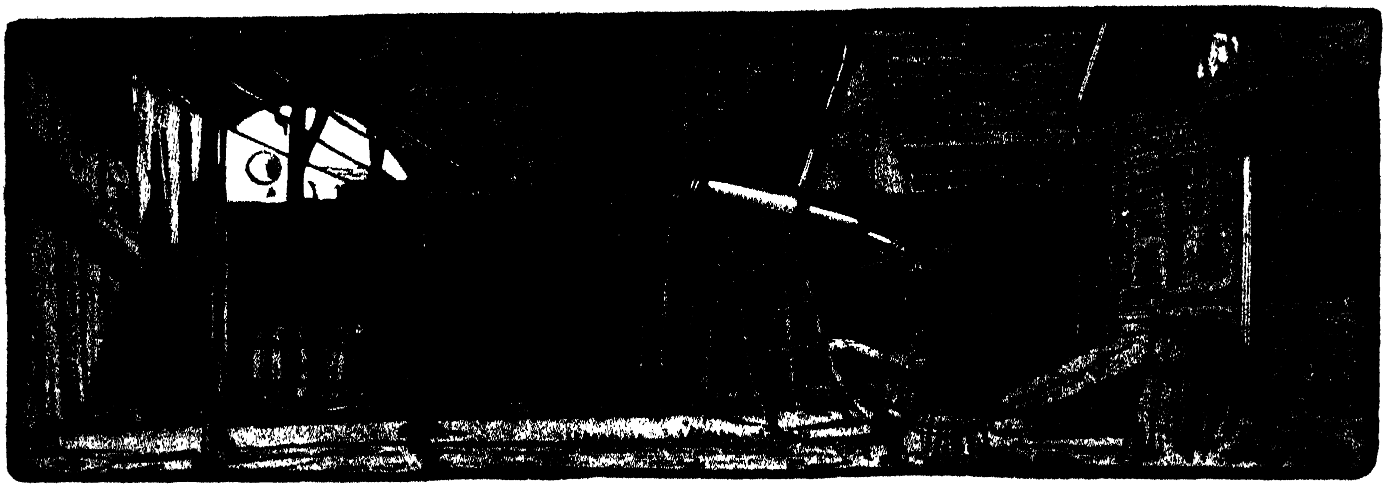


The Amateur Astronomer

THE entire inventory of materials which C. A. Olson, Oakland Avenue, Westwood, New Jersey, used in making his mirror may be seen in the photograph reproduced below. With the exception of the pitch lap, a few chemicals used in silvering the glass, and other inexpensive gadgets, the whole array is of the kind that can be picked up around the average household and is typical of the kind used in telescope making. Note absence of tools; none are used.

Simple equipment for telescope making

THE small observatory shown at the right was made by Albert F. Schroeder, 1175 Forest Cliff Drive, Lakewood, Cleveland, Ohio, and will be described in detail in a later number.

THE upper telescope on the opposite page is a four inch, made by Arthur D. Flagg, from easily obtained materials, the mirror disk being a piece of broken windshield from a motor car. Mr. Flagg used part of an old Ford water pump for his polar axis support. He also used the brass shells of discarded light sockets for making three eyepieces. A magnification of 40 or more diameters may be had from such a telescope.

P. M. JONES, 3421 Second Street, Des Moines, Iowa, whose second telescope is illustrated opposite, used the H C F lap and "found it all that was claimed for it, both in its rapid cutting and the ease of changing the tool to alter the figure." The framework of his mounting is of steel angles. This is very rigid. The yoke is made of three-inch channels welded at the joints. The telescope has a friction drive on both axes, consisting of a 10-inch disk edged to fit a small V-shaped roller held against it by a spring. Setting circles were made of lacquered protractors costing 20 cents each.

WE now continue and conclude below Professor Douglass' informative discussion of "Atmosphere, Telescope and Observer," begun in the last number:

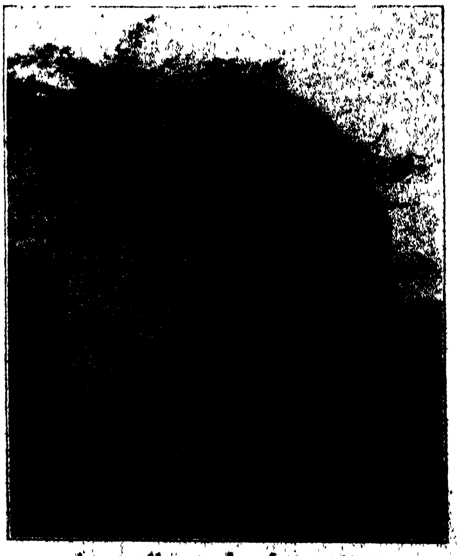
"It is easily a matter of observation that making allowance for the variation in brilliancy of the apparent field when the eye is in the focus, the atmospheric currents are precisely the same in telescopes of different apertures at the same time and place. This is of course what should be expected. But different apertures do change the character of the seeing and this also is what we expect. Conceiving the waves to consist of crests and valleys as the waves on water, we see that the refraction takes place on the slopes between these and that two adjacent slopes refract in opposite directions. If we take the distance from crest to crest as d and the mean amount of refraction in each slope as r seconds of arc we shall find that in a telescope with an aperture of $\frac{1}{2} d$ or less the image in the focus will oscillate through a distance of $2\ r$. If the aperture of the telescope is d we would see in succession, if the waves were all of perfect form, first a haziness of the planet, then a displacement of r seconds in one direction, then a haziness followed by a displacement of r seconds on the other side of its original position, then a haziness as at first, and so on; the haziness in each case being due to the presence of two slopes at once before the lens. If the aperture were $1\frac{1}{2} d$ there would be alternations of haziness with these displacements of r seconds, the displacements themselves being not entirely free from haziness. With further increase of the size of the objective, displacements would for a time exist but become more and more hazy until at last they would cease, leaving the planet perfectly steady but blurred.

"Such is the effect of using different apertures. As a matter of fact we rarely have such simple conditions in actual experience. We have a given telescope and usually three series of air waves which may all be of different sizes. By a big diaphragm we can get rid of the blurring effect of the largest set. By medium and small diaphragms we can improve successively the bad effect of the other series but in doing so the light is enormously decreased. We may summarize this matter of aperture by saying that the smaller the aperture the more bodily motion and less confusion of detail; the larger the aperture, the less bodily motion and the more confusion of detail.

"Good seeing then, apart from transparency of the air, consists of two factors, steadiness and definition. In a given atmosphere these factors vary with the aperture, one being improved at the expense of the other; either one may come from a superior atmosphere.

"Aperture has another effect on the seeing which is of different kind, namely, physiological. It principally concerns observers of planetary detail. All the effects of this kind observed, vary with the size and brilliancy of the pencil of light entering the eye. The first imperfections noticed are motes which float about and persist in coming upon the planet which is under examination. They can also be seen against a clear blue sky.

"Perhaps the most harmful imperfection in the eye is the lack of homogeneity within the more dense transmitting media, either the lens or the membranes; probably the



An easily made observatory

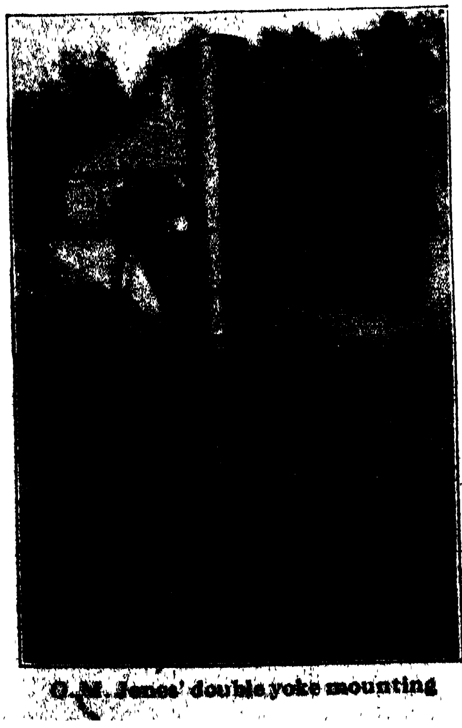
Arthur B. Flagg's trim reflector

former. Under proper conditions the lens (presumably) displays irregular circles and radial lines, the whole resembling a spider-web structure. Under actual tests this structure is so very prominent that we wonder why the eye is able to give such good definition as it does. No optician could ever sell a lens so badly made, except for the coarsest usage; in proportion to its size it has the imperfection one finds in the lens of a bull's eye lantern."

Professor Douglass next describes methods of examining one's own eyes, but this is too long to quote here.

"High powers greatly reduce contrast," he continues. "When one changes from a low to a high power the light parts of the planet become correspondingly fainter but the dark parts seem to become lighter.

"The eye has considerable power of adapting itself to contrast occurring in different intensities of light in a manner entirely independent of the size of the pupil. This has often been exemplified in the experience of visitors looking at Mars, when the emergent pencil was much smaller than the pupil of the eye; at first they see nothing but a glare of light but after looking some-



O. M. Jones' double yoke mounting

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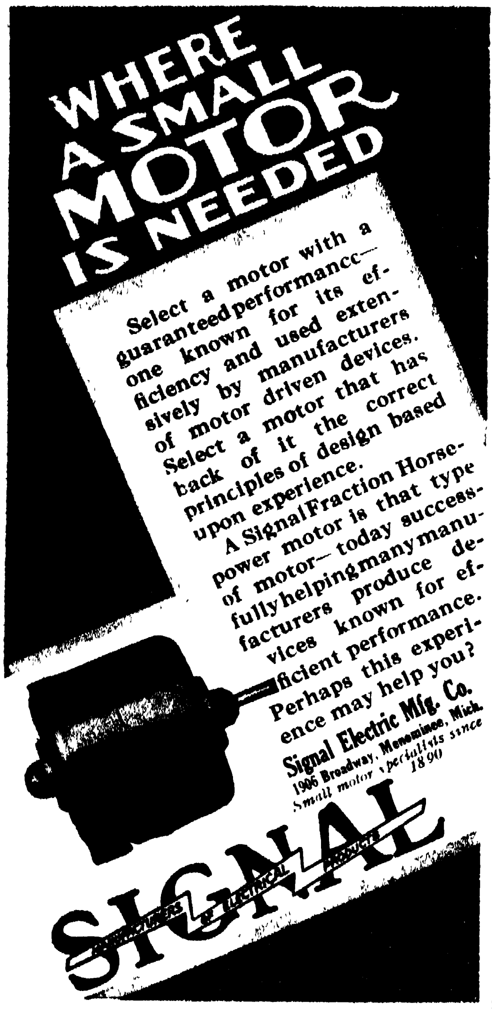

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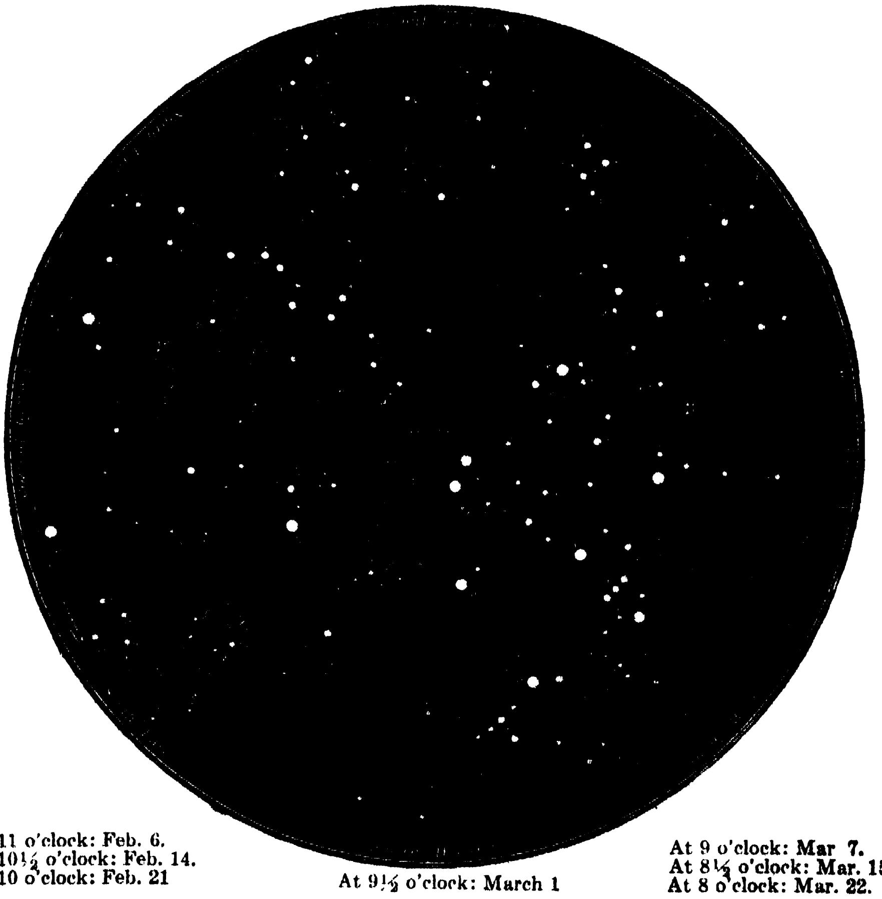
times for 12 to 15 minutes the glare diminishes and markings begin to appear. This is a certain power of adaptation which I have never seen mentioned before. After much practice that first glare becomes less and less noticeable and the eye becomes more sensitive to the particular range of contrast sought. That, in fact, is the training required by the eye to discern planetary detail, and for different planetary bodies which present different degrees of contrast and different intensities of light the training has to a certain extent to be undergone afresh in each case."

FROM Professor Douglass' article the reader will have gathered some of the basic principles of good seeing and bad. It is quite natural that the beginner should assume that magnifying power, or rather actual *seeing* power, should be increased simply by increasing the aperture of the instrument used. The matter is not, however, so simple as that; it involves a number of variable factors, variable not only from night to night but from place to place. At best any telescope is a compromise—a compromise between a number of these factors. The most elementary point for the very beginner to grasp is that mere magnifying power does not necessarily guarantee good seeing. On many occasions one can crowd on higher magnification by means of higher powered eyepieces and actually see less than with a low power. Fully to understand the considerations Professor Douglass discusses naturally requires years of patient observation under a wide variety of circumstances.—*A.G.I., Tel. Ed.*

The Heavens in February

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Feb. 6.
At 10½ o'clock: Feb. 14.
At 10 o'clock: Feb. 21

At 9½ o'clock: March 1

At 9 o'clock: Mar 7.
At 8½ o'clock: Mar. 15.
At 8 o'clock: Mar. 22.

NIGHT SKY: FEBRUARY AND MARCH

MERCURY is a morning star and is best seen about the 15th when he is 26° from the sun and rises at 5:40 A.M. He remains visible low in the dawn till the end of the month. Venus is in conjunction with the sun on the 6th but she will not come into sight in the evening sky until next month. Mars is still unfavorably placed, rising about 6 A.M. and is too low for telescopic observation of any profit. Jupiter is in quadrature on the 26th and comes to the meridian at 6 P.M. He is in Taurus, north of Aldebaran, which he greatly outshines. Saturn is a morning star, rising between 4 and 5 A.M. Uranus is an evening star and sets about 9 P.M. in the middle of the month. Neptune is in opposition on the 21st, at which time he is in Leo in 10° 18′ R.A. and 11° 18′ north declination, 3¼ degrees east and one degree south of the bright star Regulus. He is invisible to the naked eye, and the observer with a small telescope can detect him only by his motion, comparing sketches of the sky made on successive nights.

The moon is in her first quarter at noon on the 6th; full at 4 A.M. on the 13th; in her last quarter at the same hour on the 20th; and new at 9 A.M. on the 28th. She is nearest the earth on the 12th and farthest off on the 24th. During the month she is in conjunction with Uranus on the 3rd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 23rd, Mercury on the 26th, Mars a few hours later, and Venus on the 28th.

Chemistry in Industry

(*Continued from page* 157)

dissolved, and by the agency of rains, rivers, and ocean currents will also be distributed, but more slowly. The energy left in my body, after death degraded to heat, will quickly leave it and form part of the energy of the universe. This I believe to be the true resurrection of the dead, and the life everlasting. I believe in God, but like the God of St. Paul's Greeks, it is an unknown God, as in our present state of development we are incapable of understanding Him."

Ultra-violet Rays Said to Improve Flour

ACCORDING to the *American Miller*, at least one German flour mill has become convinced that treatment of flour by ultra-violet rays produces a superior product. In this mill, flour is exposed to ultra-violet rays to produce a low-cost food which abounds in the antirachitic vitamin D. Other changes occur simultaneously with this treatment and give better baking qualities and a more wholesome taste. Compared to milk, on the basis of food value, flour and flour products are said to have the advantage of greater constancy and much better keeping quality.

"All the Gold in the World" Is Not So Much

SINCE the discovery of America, world production of gold has only slightly exceeded a billion ounces, approximately 1,003,500,000 ounces being indicated by study of available records, says Scott Turner, Director, United States Bureau of Mines. More than half of the grand total of gold production for the past 435 years, or 516,273,000 ounces, was produced in the first 27 years of the present century. Of the cumulative world production of gold since 1492, 467,000,000 ounces are estimated to exist in the form of monetary stocks, while 536,563,329 ounces represent the balance of gold lost or absorbed in other than monetary uses.

The scarcity of gold may be illustrated by the fact that if the entire world production since the discovery of America were cast into a cube its edges would measure only 38.5 feet.

Rare Earths in Glass Produce Remarkable Effects

MOTORISTS may have noticed the glass tank atop the gasoline pumps in the service stations and observed that this glass if often tinted. Contrary to popular belief, this is not merely a decorative idea, but it represents a scientific effort to minimize the decomposing action of sunlight on the gasoline that stands in the glass tank. It has been found that certain elements, particularly the rare earths, impart a delicate tint to glass which filters out those rays of the sun which tend to "crack" the gasoline. Many other interesting discoveries have been made lately regarding the effect of these substances in glass; for example, a trace of neodymium in the glass of one's spectacles should partially correct color blindness.

Professor Weidert, of the Kaiser Wilhelm Institute for Silicate Research of Berlin, and director of the technical optics laboratory of the Berlin Technical High School, recently discussed the use of the rare earth elements as components of glass. He

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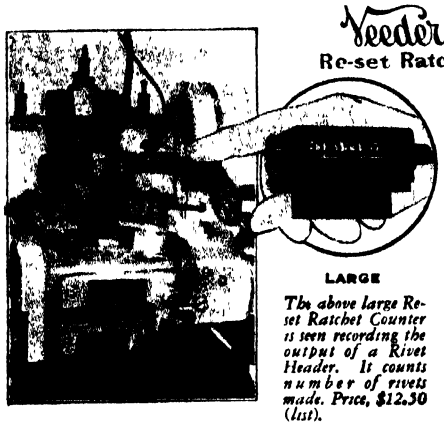
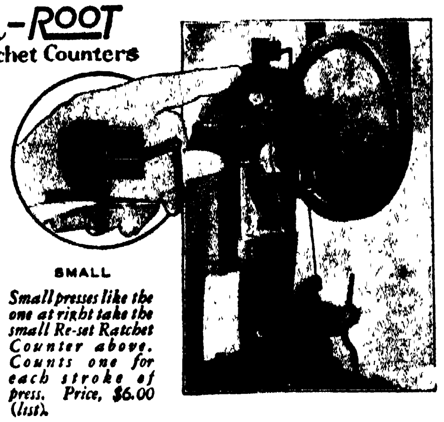


LARGE

The above large Re-set Ratchet Counter is seen recording the output of a Rivet Header. It counts number of rivets made. Price, $12.50 (list).



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Small presses like the one at right take the small Re-set Ratchet Counter above. Counts one for each stroke of press. Price, $6.00 (list).

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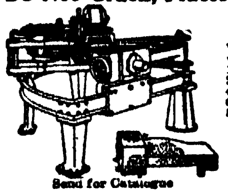

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pointed out that one gram of neodymium or praseodymium cost 20 marks before the war, but is now much cheaper. Didymium glass was used during the war for secret optical telegraphy. Glass containing cerium was used in spectacles to cut out ultra-violet light, and zirconium was used in the production of cloudy opal glass. Neodymium glass is especially suitable, by insertion before mercury vapor lamps, for the production of monochromatic light. Neodymium makes red or green appear sharper; it may, therefore, be used to correct incomplete color-blindness.

Recently, neodymium and praseodymium have been applied extensively in the manufacture of art glasses. In these, the color depends on the thickness of the glass so that parts of varying thickness show a changing play of colors; and the glass is, therefore, used in the production of artificial gems. The color also depends on that of the incident light; for example, praseodymium glass is green in daylight and colorless in candlelight.

Impregnated Hemp More Durable

A RUSSIAN chemist named Pissarew, of the Institute for Textile Research, has obtained a patent on a method of impregnating hemp by means of which, it is claimed, the durability and mechanical properties are improved very substantially. The tensile strength is increased by 50 percent, and eight years at least are added to the useful life of the hemp fibers.

The method is particularly suited for cordage, fish nets, and water hose. The impregnating substance, which is called "Naphtiol" is quite cheap, the cost of production being estimated at only about 20 rubles per 100 kilograms when manufactured on a small scale. It is obtained from residual products from the refining of petroleum. The impregnating process can be carried out in the same way as ordinary impregnation with tar.

New Borate Mineral Is Finding Commercial Use

MINERS, prospectors, and mineralogists have so thoroughly searched every nook and cranny of the earth's upper crust that nowadays new minerals are seldom found, or where they are discovered, are apt to be rare, and to exist in small quantities of no particular commercial importance Nevertheless, a new boron-containing mineral, discovered within the last five years, has been found in such quantities as to render its commercial exploitation possible, according to the Pacific Experiment Station of the United States Bureau of Mines.

The new mineral, which has been variously called Razorite or Kernite, is found in the Mojave desert of California, at depths some 600 to 800 feet below the present surface of the ground. The pure mineral is colorless, transparent, and occurs in lamellar or columnar form. It contains the oxide of boron and of sodium, together with some water, and in places is of high purity, but differs markedly in physical properties from the ordinary borax of commerce.

Its constitution has been of great interest to the chemist, who has hitherto known only the normal crystallized sodium borate, which contains ten molecular proportions of water to one of borate, and the octahedral sodium borate, with five molecular proportions of water. Both of these forms are readily soluble in water, the former being the sort found in nature as the result of the the natural evaporation of alkaline lakes. The octahedral form is unstable with respect to water at ordinary temperatures, and is not found in nature, but can be prepared in the laboratory by crystallization above 142 degrees, Fahrenheit. Chemists have not succeeded in preparing the new mineral form in the laboratory, for although it contains from three and one half to four molecular proportions of water, it is dissolved in water only with considerable difficulty. It seems probable that the material is a product of volcanic activity.

One of the larger uses for the borate is in the manufacture of certain special glass, and for glazing sanitary ware.

"Tin" Cans Made of Aluminum in Norway

THE use of aluminum cans in place of the conventional "tin" variety has possibilities of revolutionizing Norway's canning industry, according to a report from Oslo to the United States Department of Commerce. At present the experiment is limited to canned fish, 50,000 aluminum cans having been ordered for this purpose, but there is reason to believe that it will be extended.

The Norsk Aluminum Company, Hoyanger, Norway, is backing the experimentation. This firm is making plans to install rolling equipment for the special gage sheets that are required. While it is admitted that the most serious objection is the price of the new container, it is pointed out that the expense of the printed label may be done away with, as the aluminum can may be attractively embossed. The light weight, and consequent lowering of shipping costs, is said to be another advantage. Then, too, the empty cans, being pure metal, have considerable reclamation value.

It would appear that the low cost of electric energy in Norway would make for cheaper aluminum, since the production of this metal is an electrolytic process in which the cost of power is a major factor.

New Freezing Mixture

EVERYONE who has made ice cream is familiar with the rock-salt-ice freezing mixture used. When a lower temperature is desired for use in the chemical laboratory, chemists have long used a mixture consisting of one part ammonium nitrate, one part sodium carbonate, and one part water. Although this mixture permits a temperature drop of 31 degrees, centigrade, it has the disadvantages that it is expensive and the ammonium nitrate is comparatively difficult to obtain. A mixture frequently used as a substitute, consisting of ammonium chloride, potassium nitrate, sodium sulfate, and water, gives a temperature drop of only 25 degrees, centigrade. Furthermore, the price of this mixture is relatively high.

German patent 468,792, granted to W. Kasch of Berlin-Wilmersdorf, describes a mixture of ammonium chloride, sodium carbonate, and water, which is obtainable at only one fourth the price of the first named mixture and gives a temperature drop of 81 degrees; furthermore the material is easily obtainable. The best proportions in which this new mixture may be used are 100 parts ammonium chloride, 150 parts sodium carbonate, and 800 parts water.

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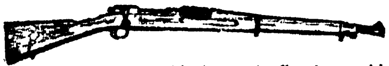

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Learning to Use Our Wings

(Continued from page 152)

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"This Aviation Business"

ERNEST W. Dichman, formerly of the Army Air Corps and now chief engineer of the Fairchild Airplane Manufacturing Company, has produced one of the best books on aviation for the lay reader that we have ever seen; "This Aviation Business" (Brentano's, New York).

The chapter entitled "The Period of Evolution" gives the right historical background. "Notable Flights and their Significance," is a thoughtful review of the solid achievement which has accompanied the adventurous flights of the past. "Commercial Development" and "Popular Enthusiasm after May, 1927" bring the reader completely up-to-date in the history of American commercial aviation.

The author is not entirely satisfied with the safety of aviation, and points out that "there is an unfortunate tendency to jump at each of the newly announced inventions as the cure for all the ills of aviation." He says, further: "The actual facts are these: There have been many all-metal airplanes catch fire and burn. Several three-motored airplanes have had forced landings. Pilots have been lost using the radio beacon. The efficacy of the Handley Page slot still remains to be proved. The N.A.C.A. cowl is still in the experimental stage, and the autogyro needs ten years' work before it will be developed to any degree of satisfaction." It is good to hear a conservative note from time to time.

At the present time great numbers of young men are seeking to enter aviation in any capacity. While aviation will grow rapidly and steadily, it is impossible that it should absorb indefinite numbers of young men. In "Aviation as a Career," the author voices a sound warning to aviation aspirants and at the same time gives an authoritative guide to training and prospects in the industry.

The author's style is really surprisingly good, particularly for an engineer, and we cannot resist quoting the following striking passage "A young man came to see me the other day. His ostensible purpose was to discuss some aviation ideas. His real purpose may be summed up by his question 'How does one git into this aviation game anyhow? This is the coming thing and I want to git in on the ground floor.' This young man happened to be a farmer. His hands and face plainly showed the marks of honest toil. He was just itching to get away from the monotony of the farm and into the air. This sort of experience, with suitable variations, is repeated on an average of once a week. Druggists, bank clerks, draftsmen, mechanics, young men of almost every calling are anxious to give up their jobs and learn to fly. One garage owner with a comfortable business was ready to sell out and take up flying. The boy who delivers my laundry recently announced that he was quitting his job to begin a course in flying at a local field."

Lieutenant Dichman first of all discusses the question of age for the would-be pilot,

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If a man is over 30 his chances of becoming a thoroughly competent commercial pilot are very small. A man in his early twenties is the most likely candidate. Under 20 he is apt to be foolhardy and reckless. Over 30 he will think too much, and this will make him over-cautious. He learns slowly, his manipulations of the controls are mechanical, and he seldom becomes a natural pilot.

For the young man of moderate means, the author advises application for admission to the Army Air Corps Flying School. If he has the necessary physical and mental qualifications he may be admitted as a flying cadet. He then receives $75 a month in addition to board, clothes, and shelter. "He will be made to do a number of things which he does not like, which will be good for him. However, he will certainly be taught to fly or gently but firmly told that he does not possess sufficient natural aptitude and be discharged."

The course of instruction lasts one year and is thorough. Time in the air amounts to about 300 hours. He may then remain in the Army or if he chooses to enter civil life, he will find many opportunities open to him. He may become a general utility pilot with some operating firm. He may do photographic work, cotton dusting, et cetera.

It is difficult to break-in with the transport companies and an apprenticeship stage as flying mechanic or assistant pilot is necessary, at 150 to 175 dollars a month. After this, he may become a regular transport pilot, and earn between 5000 and 6000 dollars a year. The author advises great caution in selecting a private school (for the man who does not get into the Army flying school) both as regards the amount of fees to be paid and the competency of the school selected.

The author covers with similar accuracy other careers in aviation—sales, drafting, engineering, operations, and so on. We advise every young man with aviation aspirations, or his parents, for that matter, to read, learn, and inwardly digest this chapter.

Aviation is passing through a period of financial depression, and the public which has financed aviation on such a generous scale is the sufferer. The following words of warning should have been written a year or so ago: "The entire nation has taken hold of the aviation idea. The tales of fortunes made in gold or oil are recalled. The automobile industry is drawn upon heavily to supply inspiration. If you had invested 100 dollars in the original Ford company you can figure out how many millions you would be worth to-day. Every investor in aviation securities considers himself a potential Rockefeller or Ford. There has been money made in aviation. There will be more money made in it. But there has been and will be a great deal of money lost in aeronautical ventures." Analysis of passenger transport is particularly pessimistic from the financial point of view.

Nevertheless, the author forecasts a great future for the industry. Central and South America will be brought close to the United States. San Francisco will be as close to New York as St. Louis is now by rail. "I confidently expect the presidential candidate of 1936 to use the airplane a great deal in his traveling."

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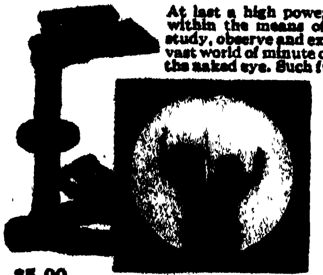

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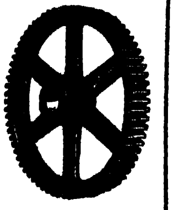

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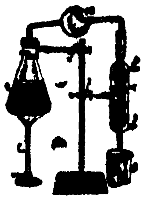

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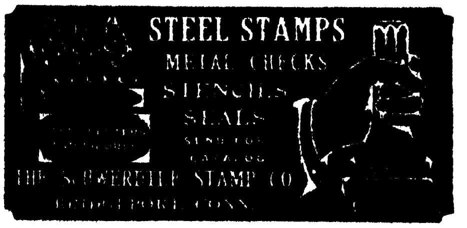

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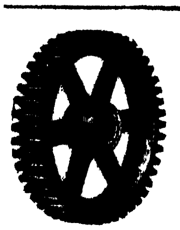

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

"Trademark Specialists" Repudiated

A BULLETIN regarding circulars recently issued by certain self-styled "trademark specialists," has been issued by the Committee on Trademarks and Unfair Competition of the Association of the Bar of the City of New York. This committee, under the chairmanship of Harry D. Nims, includes Henry T. Hornidge, Ellis W. Leavenworth, Alan N. Mann, Howard M. Morse, Orson D. Munn, A. Parker-Smith, James McKinley Rose, George W. Tucker, Wallace White, and William B. Whitney.

The bulletin follows, in full text:

The Association of the Bar of the City of New York has authorized the publication of this bulletin in order to inform the general public regarding certain fundamental principles of trademark law and to correct some erroneous conclusions or impressions which may have resulted from the recent activities of so-called Trademark Specialists who have been circularizing the business world.

1. The first person to use a trademark on merchandise acquires title thereto in the territory where his goods are marketed. Therefore the suggestion by these Trademark Specialists that the owner of a trademark is in danger of losing his mark by not having it registered according to their suggestions is entirely contrary to fact.

2. Registration in the United States Patent Office is not at all essential for the protection of vested trademark rights. It is desirable as being *prima facie* evidence of ownership (when secured under the 1905 Act), and for other practical and procedural reasons such as giving the registrant the right to use with his mark the phrase "Reg. U.S. Pat. Off." and the right to bring suit in the federal courts. The advertising Trademark Specialist in the cases investigated has exaggerated the importance of specific forms of registration and the language used is susceptible of a construction which might mislead the trademark owner as to the true situation.

3. As a rule no mistake fatal to common-law trademark rights can be made in obtaining a trademark registration, but it is usually advisable, because of the technical nature of the procedure and the probable need of overcoming Patent Office objections, that competent counsel should be entrusted with this work. The Specialist's warning that a single defect lurking in a registration may cause the loss of a mark and the good will of the business and similar expressions are obviously erroneous.

4. Vested trademark rights are recognized and protected by the courts in all the States irrespective of state or federal registration. Therefore the statement often found in some of these circulars and letters sent out by these self-styled Specialists that state registration is necessary in order adequately to protect trademark rights is not true. State registration is helpful only in exceptional cases and the trademark owner should not be burdened with the large expense involved in securing such registration except in unusual cases.

It is obvious, therefore, that the general public need not be disturbed or alarmed by the statements and veiled suggestions of disaster often found in circulars and letters which are constantly being received by trademark owners, circulated by persons and concerns thus soliciting use of their services in connection with such matters.

Rejection of Claims Due to Delayed Application

DELAY for nearly five years in making the application for reissue patent covering locomotive reversing-gear mechanism resulted in rejection of certain claims of the delayed application by the Commissioner of Patents *exparte* Henry Helmholtz *et al.* The decision was rendered on an appeal from the ruling of the examiners in chief, finally rejecting claims 10 to 16 of reissue patent Number 17483. The original patent Number 1208556 was granted December 12, 1916.

The applicants accounted for the delay by general statements that they were engaged in furtherance of the war aims of the Government and could not exploit and did not learn of the defects of the original patent until shortly before the filing of the application. This was held to be an insufficient special circumstance which would not excuse the delay in view of the fact that the patent was assigned three years after it was issued, and nearly two years before the reissue application to a corporation which furnished no excuse for its delay.

Invention Rights Barred by Disclosures of Prior Art

IT is the intention of the Patent Statute to reward invention, and not to reward diligence in unearthing prior patents which have not been turned into commercial success. A person is not entitled to the reward given inventive genius if his invention has already been disclosed to the public through the records of the Patent Office, even though the prior art device has not gone into extensive and successful commercial use, according to a decision of the Circuit Court of Appeals for the Tenth Circuit.

The case in question, W. H. Butcher Packing Company *versus* Cincinnati Butchers' Supply Company, was heard by Circuit Judges McDermott, Lewis and Phillips, on appeal from the District Court for the Western District of Oklahoma. The lower court had found infringement, awarded an injunction and directed an accounting, but the Court of Appeals reversed the decree, with instructions to dismiss the bill. The machines of both parties of the suit were found to lack novelty over the prior art, and therefore had no right to claim patent protection.

The plaintiff's patent for hog-dehairing machines, Number 1388898, issued in 1921 to Charles G. Schmidt and Oscar C. Schmidt, was held to be more like the prior art than the patent held by the defendant was like that of the plaintiff. Because of public use of the prior art machines, in which the invention had been disclosed, the later patentee has no grounds for demanding the rights of the inventor. Finding no infringement, and not passing upon the validity of the claims in suit, the court held it unnecessary to discuss presumptions, commercial success, or many other points ably briefed and argued. The decree was reversed and the bill dismissed.

Facsimile Signature Upheld

DESPITE its similarity to the opposer's trademark, the autograph-signature mark "E. W. Williams," has been upheld by the Assistant Commissioner of Patents on the grounds that a facsimile signature possesses such distinctiveness as not to be confused with marks otherwise portrayed. The ruling reversed the decision of the acting examiner of interferences, which had sustained the opposition to the registration of the signature. J. B Williams Company, owner of the mark "Williams," had contested the registration of the facsimile mark, both marks being used for cream to be used after shaving.

In holding that there was no likelihood of confusion by the current use of the two trademarks on goods of the same descriptive properties, the Assistant Commissioner pointed out that in every branch of the law handwriting is considered distinctive. The distinctiveness, in such cases, is in the penmanship and the mark is not the mere name of an individual. According to the ruling, the mark "E. W. Williams," as written, bears no resemblence to the mark "Williams," despite the seeming evidence to the contrary.

Profits from Expired Patents

MORE and more holders of valuable patents and trademarks are realizing that the best insurance for profits during the post-patent period is in building recognition for the future by extensive advertising. When patents expire, the company which has established itself firmly in the field is at a distinct advantage over its competitors, even when the industry at large is free to make use of the invention. As many patent-holders have learned, this "head start" can be perpetuated and capitalized by the judicious use of display advertising.

A slightly different result, illustrating the same principle, was pointed out recently in *Engineering and Mining Journal:*

"Basic patents on a machine used extensively by a specific industry were owned by the ABC Corporation. The XYZ Company also made the machine, along with other products, paying the ABC people a royalty for every machine sold. The XYZ Company chose to stay in business without making a practical profit on this particular product. Why?

"Two years or so ago the patents expired. The expected happened. Dozens of manufacturers turned to making the machine. But instead of diminishing sales for the XYZ Company, there came increased sales, pyramiding profits, and leadership in the field. This leadership is being maintained today by the same formula that was used steadily for three years before industry-at-large was free to make the machine.

"During the three-year period from 1923 to 1926, when XYZ's profits were barely enough to pay royalties to the patent owners, XYZ advertised regularly in certain well-chosen periodicals, building recognition for the future, intrenching themselves in a strategic position for the post-patent period. After the patents expired, in 1926, pyramided effects of continuous advertising sent sales and profits constantly upward.

"Today a sustained advertising program of full and double pages, with pithy, factful copy, is keeping the XYZ Company in top place."

Mark Suggestive of Use Held Not Descriptive

ALTHOUGH the notation, "Detective Special," the word "Special" having been disclaimed, is obviously a recommendation of revolvers to detectives and suggestive of their use, it has been held that the notation is not so clearly descriptive as to justify the Patent Office in refusing registration. The applicant, Colt's Patent Fire Arms Manufacturing Company, had appealed to the Commissioner of Patents from the decision of the examiner of trademarks. In refusing registration, the examiner asserted that the mark is descriptive of the goods, offering in substantiation of his stand a reference from the applicant's catalog describing the revolver in question as "a snub-nosed Colt shooting the powerful .38 special cartridge, yet small enough to ride handily in the side pocket of coat or overcoat."

The Commissioner concluded that the revolver has no structural characteristics which make the weapon particularly suitable for use by a detective any more than for any other person. It was conceded that the mark would be interpreted in the nature of a recommendation of the revolvers to detectives, and would function, not descriptively as to the characteristics of the articles but suggestively as to their use.

Among the references cited by the applicant in defense of the mark were, "Hotel Special," for coffee; "Cow Boy Special," for overalls; "Miner's Special," for gloves; "Planter's Special," for feed for horses; and "Banker's Special," for revolvers, showing that it is the practice of the Patent Office to register marks of such character. Concerning the trademark, "Banker's Special," for revolvers, the Commissioner said, "I fail to see any distinction as to registrability between the two marks, and feel that either both should have been registered or else both should have been refused registration. The instant mark is regarded as not so clearly descriptive of the applicant's goods as to justify the Office in refusing its registration. The decision of the examiner of trademarks is reversed."

Why Spark Plugs Do Not Crack

"THOSE who drove automobiles a few years ago will recall vividly, among other troubles, the grief caused by cracked spark plugs," we are reminded by J. T. Pardee of the United States Geological Survey, in a recent issue of the *United States Daily*. "Today we have forgotten about spark plugs. They have ceased to be a source of trouble—no one ever hears of a cracked porcelain any more."

Explaining "Why spark plugs do not crack," Mr. Pardee describes the way this improvement was brought about, an incident which clearly illustrates the value of purely scientific research carried on for its own sake and without any immediate economic object in view.

"In June, 1926, in the course of field work for the Geological Survey, in Inyo County, California, Adolph Knopf, a geologist, saw an outcrop of rock that had been taken by one prospector for silver ore and by another for phosphate. It evidently was neither, and so far as its appearance indicated was merely one of the host of rocks that compose the bulk of the earth's crust.

"However, the geologist, recognizing the mass to be of an unusual character, stole time enough from the otherwise economic work assigned to him to gather specimens and to ascertain the facts of its occurrence. Later, at Washington, an examination of his collection showed that the rock was largely composed of a mineral called andalusite. Now at that time andalusite was not known to have any economic value. But, because of its scientific interest, a description of the occurrence was published in a scientific paper.

"Before that time the silicate minerals had been one of the many subjects of investigation by the geophysical laboratory, which had, among other things, determined what to the layman might appear to be a bit of perfectly useless information; namely, the amount of swelling and shrinking shown by andalusite and other minerals when they were heated and cooled; or, in scientific terms, their coefficients of expansion.

"The geologic paper and the results worked out by the physicists fell into the hands of engineers looking for substances with which to make spark-plug procelains that would not crack, and presto!—andalusite was the answer. The geologist's research had found the deposit, and the physicist's research had shown its suitability for the purpose sought.

"Again in the course of field work, this time in the Rochester district of Nevada, the same geologist discovered another scientifically interesting occurrence, a mass of the mineral dumortierite, which, in the course of events he described and for which the physical properties had been made known as before, with the result that the spark-plug makers were directed to a deposit even more valuable for their purpose than the andalusite.

"Today, as an indirect result of purely scientific, uneconomic investigations, we drive our automobiles with never a fear of a 'missing' plug."

Electroplating Process Claims Declared Patentable

FINDING nothing in the claims that limited them to any particular apparatus, the Board of Appeals of the Patent Office has reversed the action of the examiner who had rejected as unpatentable certain claims of a process for electroplating the interior of tubes. The process claims had been rejected as not being patentable over the apparatus claims which were allowed by the examiner. The allowed claims are included in patent Number 1733404 issued to Frank A. Fahrenwald, covering both process and apparatus for electroplating tubes.

The Board of Appeals held that the apparatus disclosed, when operated in the manner described, carries out operations

Patents Recently Issued

Classified Advertising

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Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co; those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

BRAKING DEVICE FOR AIRCRAFT—By which the speed may be smoothly checked in flight, and the craft automatically maintained with safety in a fore and aft balance, so that when landing it may be brought to rest in a relatively restricted area. Patent 1731735. Marion H. Aten.

Pertaining to Apparel

GARMENT—An article of wear convertible from a plain rectangular form to be used as a steamer rug, or given the form of a wrap with sleeves and a collar by the engagement of a minimum number of fasteners. Patent 1736594. Bessie J. Hart.

BUCKLE—Including a tubular body which is adapted to telescopically receive the free end of a belt, or one of a pair of members to be connected thereby, and permit a limited relative movement between said members. Patent 1737492. William H. Carroll.

Designs

DESIGN FOR A STOCKING—Patent 79876. Ruby Left.

DESIGN FOR A DRESS—Patent 79730. Dorothy Long.

DESIGN FOR A TEXTILE FABRIC OR SIMILAR ARTICLE—The inventor has been granted nine patents for ornamental designs for textile set forth in the process claims. This fact, however, is not sufficient reason for rejecting the claims as functional, the decision stated, when such process claims are not limited to any particular apparatus. In such cases it was held that process claims should be allowed, since the process form of claim may be more satisfactory than an apparatus claim.

The application disclosed a process by which a tube to be electroplated is mounted for rotation; the anode is shorter than the tube and is caused to be reciprocated to and fro lengthwise of the tube. The liquid is circulated through the tube. One of the claims stated: "The process of electroplating the interior of a tube which contains the step of electrolysing a solution of plating metal in contact with the entire tube interior as cathode, and simultaneously impressing upon the tube and anode two independent movements, one a gradual axial movement relative to each other and the other a gradual movement of rotation of the tube around the anode."

Garment Pressing Machine Patent Upheld by Court

INVENTION, and not mere double use, is involved in applying to a steam garment-pressing machine a suction drying device taken without substantial variation from another art, where the patentee was not only the first to make application of the old device to the new use and the first to show how it could be made, but he was also the first to perceive and show utility in making it. On these grounds, the Weinberger patent (Number 1193093) for a garment pressing machine has been sustained by the District Court of Delaware, which simultaneously declared invalid the Spencer patent (Number 1326982) covering a device substantially the same. These decisions terminated a suit brought for the alleged infringement of both patents, United States Hoffman Machinery Corporation *versus* Pantex Pressing Machine, Incorporated.

The Delaware court ruled also that although an examiner had rejected certain claims of a patent application which were subsequently allowed by examiners-in-chief on appeal, a court may hold the patent invalid on the same prior art considered by the Patent Office.

It was held that the placing of old elements in juxtaposition without a new function or effect is not combination, yet when elements are so united that by their joint action on their common object they perform additional functions and accomplish additional results, the union is a true combination, and whether they coact successively or simultaneously is of no importance. Also, according to this court, the substitution of one element or device for another which performs the same function in substantially the same way and accomplishes substantially the same result, even if the substituted part performs the function better, is within the capacity of one skilled in the art and is not a patentable invention.

fabrics. Patents 79749, 79750, 79751, 79752, 79753, 79754, 79755, 79756, 79757. Frieda B. Paisner.

Design for a Dress — Patent 79887 Dorothy Long.

Electrical Devices

Alarm Apparatus—An electric burglar and fire alarm which normally utilizes the house lighting current for actuating an alarm when the surreptitious opening of a door or window is effected or when a fire occurs in the building. Patent 1732276. John A. Morrison.

Indicating Apparatus—For indicating, annunciating or displaying indicia bearing elements, which are displayed and concealed successively in numerical order, as the result of actuation of a single controlling device, including a source of electrical energy. Patent 1733817. Joseph S. Moranor.

Coin-Controlled Circuit Closer—Which automatically controlls an electric device, such as a fan arranged within a public toilet having a hinged door, upon the insertion of a coin in a coin slot and the closing of the door. Patent 1734838. Arthur W. Tucker.

Automatic Switch—A safety switch for a motor driving a given piece of machinery, which stops the operation of the machinery in case of an accident, but does not stop the running of the motor. Patent 1735761. James E. Huey.

Television Apparatus—A system employing a square scanning beam upon a photoelectric cell controlled by two rotating spherical surfaces, the axis of which are disposed at right angles to each other. Patent 1735553. Samuel T. Syphrit.

Electric Advertising Device—Wherein round or other shaped articles are provided with a magnetic member which co-acts with means forming a field whereby as the field is energized the article is moved about without apparent cause. Patent 1736613. Guy McGoshen.

Of General Interest

Submarine Safety Device—Including a marking buoy controlled from the interior of a submerged vessel, and a cable attached thereto which will draw upwardly a normally collapsed hose, through which the crew of the disabled vessel may be rescued. Patent 1734864. Willy Krause.

Holding Means for Vanity Cases—The holding structure for the removable plates being swingably connected to the casing and constructed to hold any kind of powder, rouge and like renewals which may be applied without the use of tools. Patent 1734860. William G. Kendall.

Skylight—Which is fireproof, and comprises a metalic frame structure made of separable members so that the skylight can be disassembled and shipped in knock-down condition, and secured without the use of solder, bolts or other fastening elements. Patent 1734840. Sidney Volk.

Photograph Exhibitor—Comprising a cabinet having a plurality of supports for the mounting of photographs on one or both sides, the supports being movable in the order of book pages thereby successively displaying the pictures to view, without injury by handling. Patent 1734790. Helmuth F. Bandt.

Shaving Brush—Wherein the handle and brush element are separable, the brush consisting of a flexible bristle carrying strip helically wound and detachably held within the handle so that after use the bristles may be thoroughly sterelized. Patent 1734873. William M. Neissl.

Combined Arm Rest and Prop—Which may be readily adjusted for use as an arm rest or a prop, and will serve advantageously on a com-

Fur Company Denied Use of Name "Hudson"

UPHOLDING the rights of the historic firm known as the Hudson's Bay Company, chartered by King Charles II in 1670 under the title, "The Governor and Company of Adventurers of England Trading Into Hudson's Bay," the District Court of Minnesota has ruled that no other firm dealing in furs and blankets can do business under a firm name containing the words "Hudson," or "Hudson Bay." The above firm had opposed an application of the "Hudson Bay Fur Company," for permission to continue its established business under the revised name, "Hudson Furriers, Incorporated."

The Minnesota court ruled that the defendant, by improperly adopting the name "Hudson Bay Fur Company," had been in error, and despite the fact that large sums had been spent in advertising the improperly acquired name, it should discontinue the use of the word "Hudson."

The court said: "If defendant had never used the name 'Hudson Bay Fur Company,' the wrong and deception, if any, involved in now using the name proposed (Hudson Furriers, Incorporated) would be much less than it would be under conditions as they actually exist. The application of the defendant seems like an effort to see how far it will be permitted to go, without incurring the penalties of the law, along the lines on which it should never have entered at all.

"The world is wide, and available and good names for defendant's business are many. It has a great range of selection without trespassing upon the rights of plaintiff, and without, by a possibility, deceiving the public. Some such name should be chosen. In the face of the decree which has been entered in this case, the defendant has continued to use and advertise under the prescribed name for quite too long a time. The matter should now be promptly closed, and changed conditions, conforming thoroughly to the spirit of the decree, should be inaugurated without delay."

Examiner Upheld in Ordering Drawings Corrected or Withdrawn

WHEN drawings submitted with an application for patent are lacking in conventional symbols specified by the Rules of Practice for all applications involving electrical systems, the examiner is justified in ordering the drawings corrected or withdrawn. This decision was made by the Commissioner of Patents, acting on a petition from an order from a patent examiner.

Although the art generally may use different symbols in illustrations, uniformity is declared to be necessary in patent applications in order to facilitate clearness and accuracy on the part of the examiners. For many years a chart for the guidance of draftsmen as to the use of symbols in connection with wiring diagrams have appeared in the Rules of Practice. This chart has been modified from time to time as the practice adopted by engineers and others skilled in the arts has changed or advanced. The application's drawing (*ex parte* Rodman), the examiner's requirement, and the applicant's petition were submitted to each of the five principal examiners in charge of the respective divisions of electricity, for comment. At least four of them strongly supported the requirement of the examiner, in the interest of clearness and accuracy. This action of the examining staff and the Commissioner of Patents emphasizes the importance of having applications and drawings prepared by attorneys and draftsmen thoroughly familiar with the Rules of Practice as revised to date.

bination folding chair and cot in connection with one of the sections. Patent 1736569. Arthur F. Bailly.

Method of Welding Copper-Boiler Ends—Whereby an extra-thickened portion presenting an internal bead at a point where the head joins the shell is caused to fuse and extend inwardly, presenting a strong structure, which is water and steam tight. Patent 1733922. Albert H. Trageser and Louis Hassinger.

Holding Ring for Compact Plates—Comprising an annular tubular ring structure wherein one or more corrugations are provided, whereby different shaped compact plates may be properly engaged and held resiliently and removably in place. Patent 1734859. William G. Kendall.

Tray—A serving tray consisting of two parts, a frame and an article holding plate, the plate resting in contact with the frame and handles which hold it from slipping, yet may be easily removed for interchange or cleaning. Patent 1733838. Malcolm Steiner.

Brush—A hair brush of the type which includes a handle and a detachably associated bristle carrying section which may be easily disassociated to permit of a thorough cleansing and sterilizing of the parts. Patent 1735802. Rocco Statuto.

Bottle Crate—Particularly designed for transporting milk bottles, including non-metallic vertically arranged partitions of a size and spaced in such manner as to reduce chipping and breakage, and minimize noise in transportation. Patent 1735772. John F. Maurer, Jr.

Ventilator—Particularly adapted for location in the ceiling of a room, for transforming horizontal circular motion into vertical circular motion, giving a maximum air space from a minimum area occupied by the device. Patent 1735760. James R. Howard.

Traps—For rodents, including a box of tapered construction, a door mounted for up and down sliding movement within channels, and a bait holder and latch rod, the disengagement of the bait automatically closing the trap door. Patent 1735786. Sherman S. Pearl.

Wheelbarrow—In which an auxiliary rear wheel is provided for relieving the operator of a portion of the load, but is adjustable for support at various heights without the necessity of releasing the grip on the handles. Patent 1735527. John Cwik.

Shield for Cooking Stoves—Readily adjustable, and whereby the cook is protected against the fumes and heat rising from the stove and food, yet permitted a clear view of the food, and in no way interrupted with the manipulation thereof. Patent 1735806. James F. Struble.

Safety Razor—Wherein a hollow handle is provided which constitutes a container for the remaining parts so that when not in use they may be arranged into a small compact package. Patent 1735751. Thomas C. Green.

Adjustable Chair Seat—Which can be satisfactorily used in connection with lunch counters or the like, and is characterized by means permitting of quick and convenient adjustment to afford maximum clearance between the seat and the counter. Patent 1735804. George B. Travis.

Record Binder—Of the loose-leaf type, which will be of all metal construction, extremely durable and efficient in use, yet will permit of light-weight construction of the parts. Patent 1736711. Ernest W. Jackson.

Container Cover—Serving as a sealing for preventing leakage of the contents or excluding air therefrom and including a compartment for holding a direction-bearing pamphlet in such manner that it will be displayed when the cover is removed. Patent 1736286. Clen S. Humphrey.

Visible-Card File Cabinet—In which each drawer is hinged at its inner end to a latch member adapted to normally prevent the drawer from being entirely withdrawn from the cabinet, and to support the drawer depending if desired. Patent 1736655. Lugi Lombardini.

Loose-Leaf Binder—Comprising a binding member in the form of a strap which extends through slots in the aligned perforations of a plurality of sheets and is fastened to prevent accidental movement of the sheets. Patent 1735031. Royden E. Beebe, Jr.

Bedcover Folding Device—Which functions on any conventional form of bed, to render available as bed covering the entire length of the blanket and other coverings, by eliminating the necessity of tucking covers beneath the mattress foot. Patent 1736212. Benjamin A. Moeller.

Coupling Device—For connecting necklace or locket chains, including a pair of rotatable notched elements connected for movement in opposite directions, the notched portions receiving and completely embracing an article to be coupled. Patent 1737481. Michael Rabb.

Inscription Device—For sand blasting letters or other configurations upon tomb stones, whereby special designs may be set up and pressed into a prepared coating for cutting out, the letters being more accurate than when cut by hand. Patent 1737500. George B. Johnson.

Umbrella—A collapsible umbrella, including channel shaped members one of which is slidable within the other, and pivoted ribs, the parts being arranged so that it can be carried in a hand bag. Patent 1737464. Henry R. Lillich and Carter Smith.

Playing Cards—Of what may be termed the standard type, with the suits so marked with distinguishing elements that one of the suits may be told from another, at a glance as they are fanned in the player's hand. Patent 1737478. Jesse E. Simmons.

Directory Board—Primarily adaptable to city maps, enabling a stranger to quickly locate a desired street or place, the function being electrically performed by pressing a button, the device may also serve as an advertising medium. Patent 1737520. Thomas P. Richardson, Jr.

Valve for Fuel-Storage Tanks—For trapping and preventing water which has seeped into gasoline or kerosene storage tanks from being sucked into the pump, and also functioning to warn the pump operator should water have gotten into his tank. Patent 1737529. John H. Viele.

Hardware and Tools

Pipe-Reaming Attachment for Pipe Threading Tools—By which reaming the pipe for removal of burrs is accomplished simultaneously with, and by operation of the threading tool, thus upon completion of threading the pipe is devoid of interior burrs and ready for installation. Patent 1731727. Max Richman and Harry H. Leon.

Bending Tool—Particularly adapted for use by workers on building construction jobs, for the purpose of carrying out clip bending operations in conjunction with structural elements to support the latter in readiness for application thereto of other structural material. Patent 1736585. Fred R. Fehlhaber.

Gauge for Applying Hinges—By virtue of which inserted leaf hinges, where it is necessary to cut an angular groove, may be rapidly applied with accuracy, and without requiring the mechanic to resort to unnecessary measurements. Patent 1736709. Ernest Flagg.

Supporting Device for Rails—Comprising a base or wheeled truck, having U-forms constructed of metal mounted thereon, for holding the side rails of a ladder or scaffold, and threaded studs for securing the rails in fixed position. Patent 1736501. John J. Macklem.

Carpenter's Level—In which the number of bulbs usually employed is reduced by combining with the straight edge a circular bulb allowing a reading to be conveniently taken, whether disposed vertically or horizontally. Patent 1736502. Robert B. Maddox.

Heating and Lighting

Marine Signal Light—A portable signal light adapted for marking the location of buoys, dories, channel stakes, fishing gear, etc. The portable nature of the device makes it useful generally where a signal light is needed. Patent 1735797. Louis T. Scott.

Automatic Control Apparatus for Gas Burners—Which can be set to any required opening by hand and is subsequently controlled by means of a thermostat for the purpose of keeping the temperature of an oven or its equivalent substantially constant. Patent 1736649. James Dolphin.

Damper Control—A special operating element for the damper control of heating or ventilating pipes and means for locking the damper in any adjusted position, rattling due to draft through the pipe being prevented. Patent 1735034. Frank H. Bryant.

Machines and Mechanical Devices

Belt Tightener—Automatically operated for maintaining the constant engagement of a belt with the drive pulley and a variable engagement with the driven pulley, so that as the tightner moves toward the driven pulley the frictional engagement is increased. Patent 1737467. Paul E. Mahaffey.

Washing Machine—Including inner and outer casings of the reciprocating types, with cleaning solution inlets and outlets, wherein clothing is subjected to the washing process in an easy manner, and in less time than is usually required. Patent 1737480. Max Troy.

Concrete Mixer—And transporting tank, which operated in one direction will mix the sand and cement, and in another position will propel the mixture to a discharge point, adding the water immediately before the discharge of the concrete. Patent 1737522. Carlyle H. Scott.

Combined Display and Vending Machine—A coin operated machine which prominently and attractively displays the merchandise which it handles, is adapted to handle a wide variety, yet permit the selection of any particular article, which will be automatically dispensed. Patent 1737499. Robert C. Hardman.

Fruit - Pitting Machine — Particularly adapted for removing the pits from dates by an intermittent motion, means being provided for holding the fruit, and positioning the pit within the path of a knife for longitudinally slitting the fruit and ejecting the pit. Patent 1734010. Anthony Gotelli.

Paint Roller—For applying paint to collapsible tubes, at the same time preventing injury and correcting irregularities in the tube to a certain extent, while applying the paint in a properly coated form. Patent 1733898. Frank J. Lynch.

Atomizer—By which a thorough atomizing and intimate mixing of liquid fuels, such as crude oil or other hydrocarbons, and air will be effected, and ejected at a high velocity thereby obtaining a highly combustible mixture. Patent 1733413. Oscar Kay.

Combination Bailer, Dump and Pump—Characterized by features of construction and operation by which the device may be readily converted to adapt it for carrying out bailing, dumping and pumping operations in sinking well holes. Patent 1733837. Harry J. Steinberger and Harr A. Miller.

Stock-Feeding Means—For machines effecting dual operations upon stock, the stock being fed to one part of the machine, operated upon, and then returned to another part of the machine for a subsequent operation. Patent 1734868. David E. Milne.

Plug Packer—Having means by which it may be determinately positioned above the bottom of a well hole to shut off gas or water strata below the oil bearing strata. Patent 1734884. Edward E. Simpson.

Vegetable Cutter—A machine of comparatively large capacity, whereby vegetables or fruits may be cut, chopped or minced in an expeditious manner. Patent 1735702. Harry M. Williamson.

Machine for Processing Fibrous Filling Materials—Including, cotton, cotton waste, down, feathers, hair, floss, kapok, jute and similar materials, such as are commonly used in filling mattresses, pillows, cushions, etc., consisting in beating, cleaning and mixing the materials. Patent 1735749. Max Goldberg.

Safety Attachment for Extractors—For laundry machinery, for positively preventing the opening of the cover until the machine has reached a dead stop, or starting the machine until the cover is completely closed, thus safeguarding operators against injury. Patent 1735745. Joseph Gariglio.

Measuring Device—For gasoline apparatus, which will positively determine the quantity of gasoline dispensed by a weighted element that controlls the operation of a reciprocating tank, by movement of the weight to a point indicating the quantity required. Patent 1735729. John K. Carter.

Wood Trimming or Edging Machine—Wherein a plurality of superimposed barrel staves or other flat longitudinal members may be trimmed along their edges in a single operation, and after trimming will be caused to fall into a receptacle. Patent 1735792. John C. Ramsey.

Saw Table—Having a removable top with a plurality of slots through which gauge bars may be projected at predetermined distances from each other and from a circular saw, for cutting boards lengthwise at a predetermined width. Patent 1735773. William P. McIlvanie.

Plunger—For air pumps, having a cup formed of leather or suitable composition in which is mounted a resilient member adapted to counteract the deformation while retaining the cup walls in contact with the cylinder walls. Patent 1735757. Ernest W. F. Herrmann.

Lubricator—An automatic mechanism which will feed lubricant from a reservoir by the action of centrifugal force to a bearing as the latter is heated, the lubricant being cut off from the bearing as the latter cools. Patent 1735266. Leslie C. Dutro.

Spinning and Twisting Frame—Having a special form of stop motion for arresting the machine when the bobbins are full, thereby ensuring that each doffing shall be of uniform weight and length; the machine may be very easily started. Patent 1736656. Lewis Lumby.

Die for Imprinting Plastic Masses—An imprinting machine for dough blanks or masses prior to the baking thereof, the parts which are made of aluminum or other non-rusting material, may be readily separated to permit of cleansing. Patent 1736579. Meyer Collis.

Speed-Control Pulley—By means of which a belt connected with a machine may be driven at the same rate of speed as the pulley, or at varying degrees, or completely arrested, without removing the belt from engagement with the pulley. Patent 1736578. Joseph Chudner.

Macaroni Mold—Having means for forcing the macaroni paste through a die plate and for forming curly or spiral macaroni of tubular formation having a longitudinal passage or opening extending throughout. Patent 1736611. Giuseppe Lubrano.

Means for Impregnating Felt or other Fabrics—In a specially formed tank for holding the fabric, such as floor-covering or roofing, to be impregnated with a suitable oxidized, rubbery asphaltum or other saturant, that they may be elastic, strong, taut and water-proof. Patent 1736633. Karl H. Schutte.

Tackle to Support Scaffolds or Similar Devices—Which will permit the workman who is standing on the scaffold to control, at will, the height of same with regard to the ground without the least danger of accident to himself or fellow workmen. Patent 1736723. Manue A. Serra y Perez.

Feed-Gate Control—For cutting off the supply of grain or other material after a certain amount shall have passed into the buckets of an endless chain elevator, thereby preventing choking while running at full speed. Patent 1736691. Ole F. Aplin.

Joiner—Having means for automatically feeding warped or uneven boards into the machine and holding them in position while advancing against the planers, to insure a true and even surface when the board comes from the machine. Patent 1736641. William G. Zimmerman.

Elevator—Particularly adapted for freight, one of the outstanding features being its automatic operation which is performed by the dumping of the object upon a certain lever forming part of the elevator. Patent 1736584. Federico G. Diago.

Medical and Surgical Devices

Diathermy Knife—For use where electricity is employed in tonsil-lectomy, comprising a cutting blade and insulating material against the edge, whereby a tonsil may be cut, the tissue destroyed, and the tonsil removed without bleeding. Patent 1735271. Sutten H. Groff.

Method of Manufacturing Dry Yeast for Medical and Pharmaceutical Purposes—Consisting in subjecting yeast to the action of alcohol at a temperature of 55 to 65 ° C., extracting the liquid, drying the resulting mass, and subjecting this mass to the action of heat at a temperature from 150 to 160 ° C. Patent 1736657. Cornelius Massatsch.

Medicament Applicator — Particularly adapted for applying a medicament to the cervix uteri, having a cup-shaped member at the discharge end to fit over the mouth of the cervix, so that the treatment may be direct. Patent 1737454. Ernest L. Foley.

Musical Devices

Harmonica Holder —Capable of being folded into a substantially flat or nested position, but when in use, will firmly hold the harmonica in position for operation against the mouth, or in an out of the way position. Patent 1734799. Leigh A. Elkington.

Plumbing and Fittings

Closet Bend—For connecting a water closet bowl with the soil pipe, having a non-siphon inlet whereby water coming from that end which connects with the closet will not cause siphoning in other fixtures connected with the inlet. Patent 1733823. Osgood M. Redlon.

Prime Movers and Their Accessories

Piston—Having means by which the skirt can be shortened in length and yet overcome the tendency of the piston to rock in the cylinder, particularly adapted for use in internal combustion engines. Patent 1733422. Albert Mertz.

Internal - Combustion Engine—Having an auxiliary piston co-operating with the working piston to maintain compression within the cylinder while passing over dead center, no compression being lost, and ignition taking place when the crank arm is in most effective position. Patent 1734867. Douglas J. Martin.

Noise Eliminator for Internal-Combustion Engines—For use on crank case opening covers and pans for absorbing and liberating metalic vibrations, there is no metallic connection between the adjoining parts, and oil-tight joint being formed without constant attention. Patent 1737466. Harry J. Lynd.

Pertaining to Recreation

Toy Windmill—Comprising a figure with waving arms, acting in a very life like manner, a plurality of sets of oppositely revolving wind driven means, and electric lights to illuminate the device while in motion. Patent 1734858 John F. Keller.

Amusement Ride—Wherein the carriages or cars may be moved up and down as they move in a circle, or may move upwardly and then in a circle giving to a limited extent the sensation of flying. Patent 1734856. Jacob Irsch.

Game Apparatus—For playing indoor golf under similar rules governing the game as played outdoors, the game board being laid out to simulate a course with tees, fair ways, putting greens, hazards and lines indicative of "hooks" and "slices." Patent 1735794. Herbert H. Bristow.

Hand Fishing Net—For landing fish after they have been caught and drowned, equipped with a readily adjustable loop for supporting the net at the fisherman's side at a height to obviate its entanglement with obstacles on the ground. Patent 1736624. Allan S. Richardson.

Pertaining to Vehicles

Light Projector—A headlight mounted to conceal the source of light from the front of a vehicle and reflect the rays downwardly and forwardly toward the ground, without causing glare in the eyes of approaching drivers or pedestrians. Patent 1731125. William M. Cassetty, Jr., William C. Alford, and Frank L. Ross.

Convertible Seat for Motor Vehicles—Whereby the conventional type of built-in seats of an automobile may be easily converted into a bed substantially the width of the vehicle body, or reversible so that the occupants may face the rear. Patent 1732151. Frank A. Clark.

Summer Top for Automobiles—Adapted to extend over the roof of the automobile in slight spaced relation thereto whereby the auxiliary top will receive the direct sun rays, and thus protect the roof from blistering and damage. Patent 1733007. Sigurd M. Dahl.

Combined Starter Switch and Choke—Which will serve as the usual choke rod and as a circuit closer for controlling an electrical circuit to the usual starter, may be adjusted to any desired position while the motor is in operation. Patent 1733911. Gloyd L. Seifert.

Shock Absorber—Constructed so as to afford relatively large and small by-passes for fluid to compensate for weak or strong recoils, and to provide a large by pass for return of the fluid. Patent 1734857. Edwin S. Kant.

Direction Signal — Which utilizes the vacuum produced at the intake manifold of the vehicle's engine for actuating a semaphore arm by which the movements of the automobile may be conveyed to pedestrians and vehicular traffic. Patent 1734094. George MacKay.

Windshield Wiper—In the form of an attachment, in which a swinging motion is imparted to clean a sector shaped space, and electrically heated means and cutting means, for melting the snow or ice and scraping the same away. Patent 1735070. Joseph M. Young.

Automobile Control Mechanism—By means of which the motor is automatically used as a service brake through the operation of the usual control levers in the usual manner, thus eliminating wear and tear and reserving the brake for emergency. Patent 1736089. Paul G. Peik.

Slack Adjuster for Brakes—Which may be readily adjusted to take up anv appreciable wear on the shoes, and will not readily get out of order, notwithstanding weather conditions. Patent 1735752. Jesse R. Grube and Louis F. Munsch.

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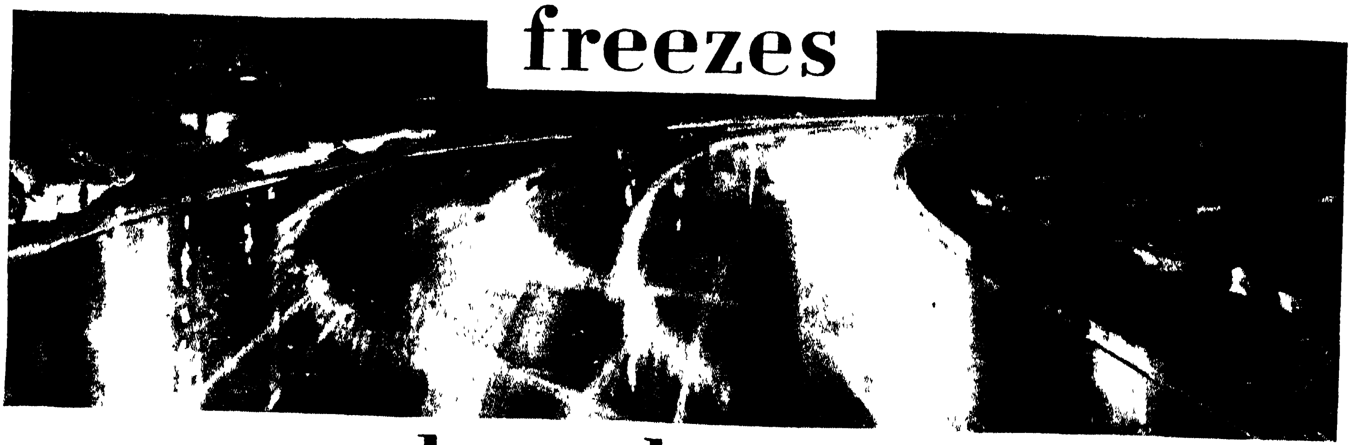

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Looking Ahead *With the* Editor

April—Engineering Number

IN our modern civilization, engineering plays such an important rôle that SCIENTIFIC AMERICAN readers have requested an issue containing more than the usual number of articles on the subject. This we have scheduled for the month of April. Articles in that issue will take the reader on an imaginary journey, first to New York where the Chrysler Building has recently overtopped all other man-made structures; thence through a roundhouse where he may see the human as well as the technical side of railway engineering; from there to Montana to see a huge coal-stripping mine; on down to California to see the result of a novel method of land fertilization by engineering methods—by reclamation; and finally, to France to watch the unique construction methods used in building a beautiful concrete arch bridge which is just about complete. Along the way, the reader-traveler may stop off to see smaller but none-the-less interesting projects under construction.

Snapshots From the Air

WHEN you travel by train, steamer, or automobile, you probably take along a camera. When you made that last journey by air or took that last short hop, did you think of carrying a camera? You probably didn't realize that the amateur can take pictures from the air as well as on the ground. Read the article on amateur aerial photography in a coming issue so you will be prepared before you take to the air again.

"You Can't Win!" Against Them

THE joke: "Another policeman for New York!" which used to be in order when an Irish boy was born, is out of date. New York City policemen are now made, not born. They go through a rigid course of training in the new Police College which gives them not only a knowledge of the business in hand but also an understanding of criminals. This truly scientific college, on the faculty of which there are many able men, will be discussed here in the near future.

Secrets of the Mummies

YOU'VE heard so much about Egyptian mummies that you realize how many scientific facts can be learned from them. It is the same with the mummies of ancient Peruvian Indians. An article on hand, based on mummy and skeletal evidence, gives an insight into their culture and some of the diseases from which they suffered. Very little has been published on this subject heretofore, so you'll find this article stimulating.

Every Issue Fully Illustrated

¶ *Read this magazine carefully. If you like it, you will like succeeding issues also. Better make sure of getting it regularly every month. A subscription, costing only four dollars, brings 12 issues to you.*

Among Our Contributors

H. Barjot

DR. BARJOT of the faculty of the University of Bordeaux has been an attaché on the staff of the great Belgian mining company in Africa, the Union Minière du Haut-Katanga, which, although a young concern, has the world monopoly of radium production and whose copper production bids fair to lead the world. When his Arctic power project was submitted to the French Academy of Sciences, the president of the Academy, M. Lecornu, discussed it favorably before the Institute of France, pointing out its economic importance for the future.

Carl G. Hartman

DR. HARTMAN of the Carnegie Institution chooses to do advanced research in embryology at Johns Hopkins University. He is a Texan, and his past research has involved studies of the habits of solitary wasps, the embryology of the 'possum, and the physiology of reproduction. Most of these researches are of a nature to arouse defense mechanism in the minds of some people but Dr. Hartman believes in calling a spade a spade when by so doing he can demonstrate scientific truths.

Peter V. Karpovich

NOT content to accept old theories relative to the speed and efficiency of swimming strokes, Professor Karpovich preferred to determine facts. With his ingenious Natograph, he has already upset some old beliefs and it is possible that his further researches may revolutionize certain phases of physical education teaching.

R. W. Wood

PROFESSOR WOOD, of Johns Hopkins, is a widely known figure in the world of physicists. His work consists mainly in experimental, rather than formal teaching. The number of interesting researches he has led—such as submarine location (during the World War), mercury telescope mirrors, exposing of Blondlet's famous, or rather infamous, "N-rays," the super-sonic ray (the "death ray" of sensational periodicals)—are almost unlimited. He works on things that are intrinsically interesting and he makes them extrinsically more so.

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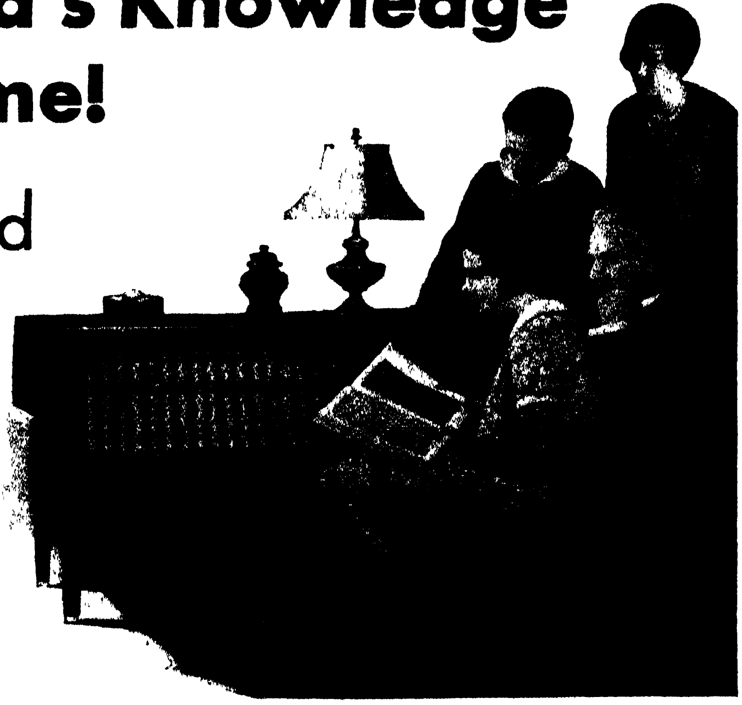

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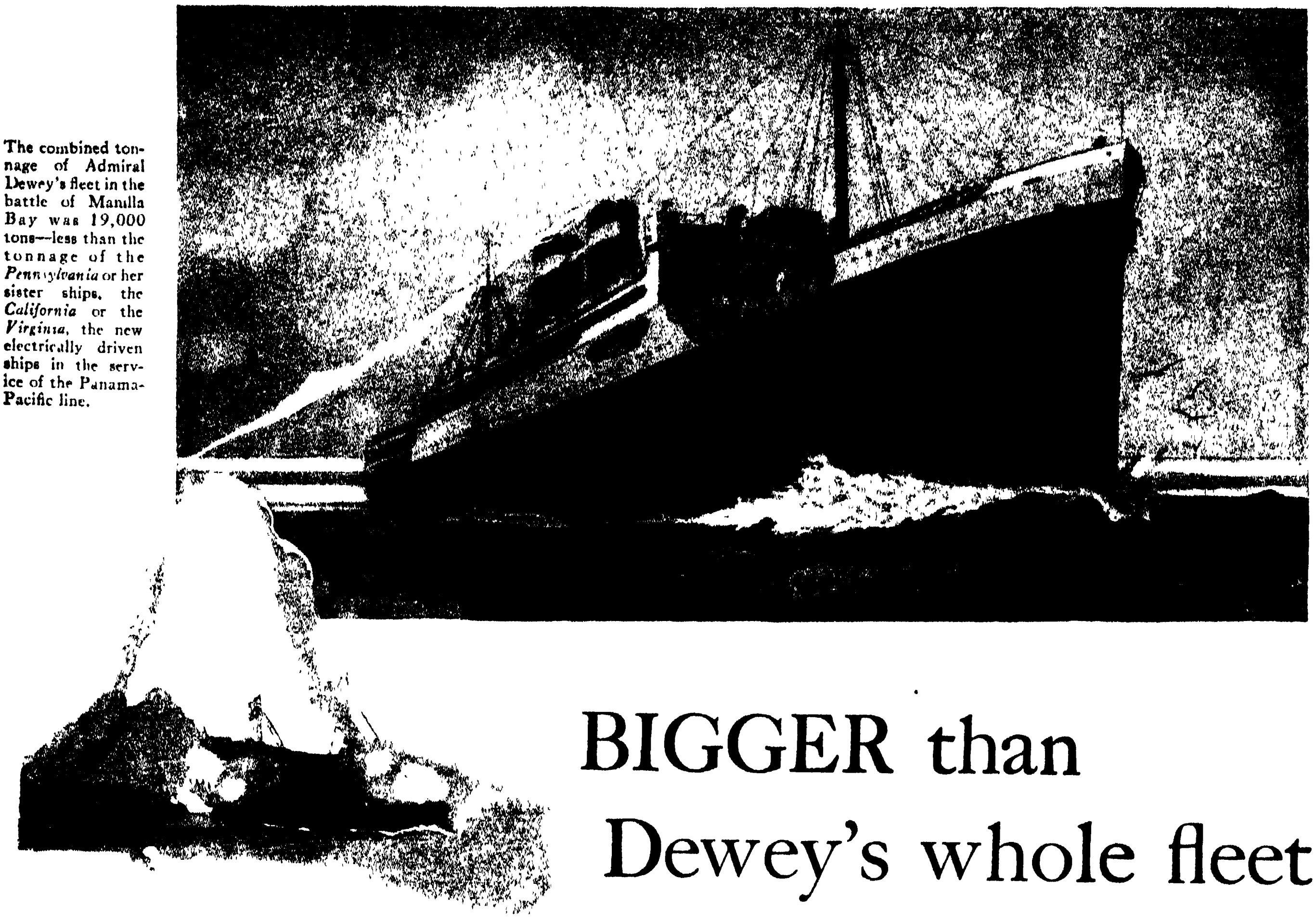

The combined tonnage of Admiral Dewey's fleet in the battle of Manila Bay was 19,000 tons—less than the tonnage of the *Pennsylvania* or her sister ships, the *California* or the *Virginia*, the new electrically driven ships in the service of the Panama-Pacific line.

BIGGER than Dewey's whole fleet

BUILT not for war but for peace, the 35,000-ton *S. S. Pennsylvania* is not only bigger than all the ships of Dewey's heroic squadron put together, but more efficient than any of them. Her 17,000-hp. motors have enabled the *Pennsylvania* and her sister ships, the *California* and the *Virginia*, to cut the coast-to-coast schedule of the Panama Pacific line to thirteen days, and have set a new standard of noiseless, vibrationless ocean travel.

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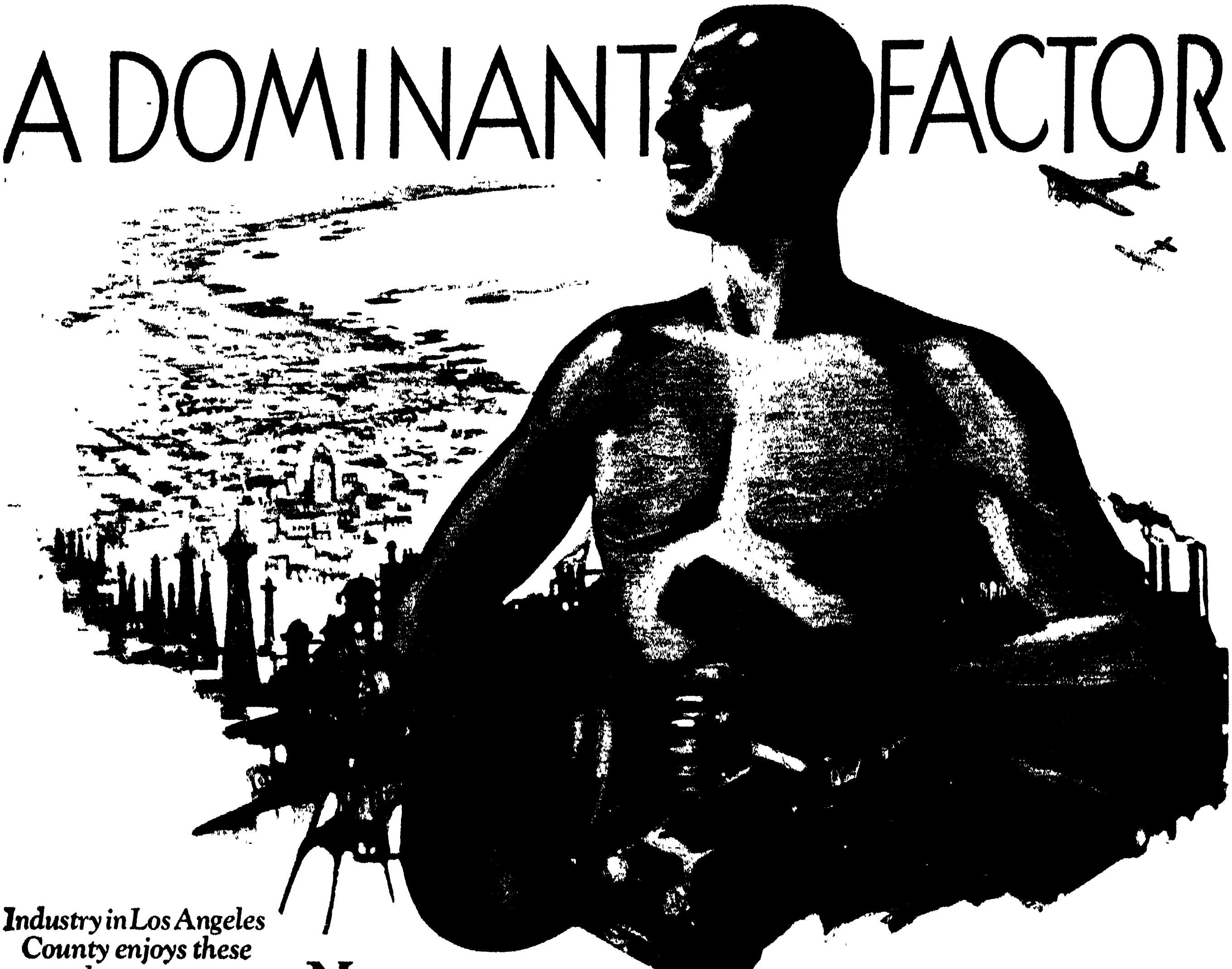
COVER

In the design from which our cover was painted by our artist, Howard V. Brown, the noted architect Francis Keally brings the airport to the city or, to be exact, redesigns a great city around its airport. He has visualized a circular airport over a mile in diameter with space for hangars, mooring mast, hotels, et cetera; a wide park to surround the landing space; and streets radiating from the airport. Mr. Keally advocates the pneumatic tube mail delivery system outlined in our article on page 210, and predicts that this method of expediting mail and express to and from the landing platform will be incorporated in important airports of the future.



A DOMINANT FACTOR

Industry in Los Angeles County enjoys these advantages:

• • • •

Year 'round equable climate, providing ideal living conditions and high working efficiency, low building and maintenance costs.

• • • •

Contented Open-Shop Labor.

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Largest local market and most efficient distributing center in the entire West.

• • • •

Unexcelled transportation, giving favorable access to the markets of the Pacific Coast, to Atlantic and Gulf States and to the undeveloped export markets of the Far East.

• • • •

Abundant industrial power, natural gas and water at low rates.

NATURE'S generosity has had much to do with the tremendous growth of population and industry in Los Angeles County. But there is another vital contributing factor. It is the spirit and vigor of Youth... the vibrant enthusiasm for achievement, inspired by opportunity and environment. It is observed and commented on by business analysts and leaders of industry. It is virile...real...tangible.

It has made Los Angeles County the biggest concentrated market on the Pacific Coast. It has given to Los Angeles in 1929 the highest bank clearings of any city on the Western Slope. It has increased industrial production 163 percent and harbor tonnage 6,000 percent in ten years.

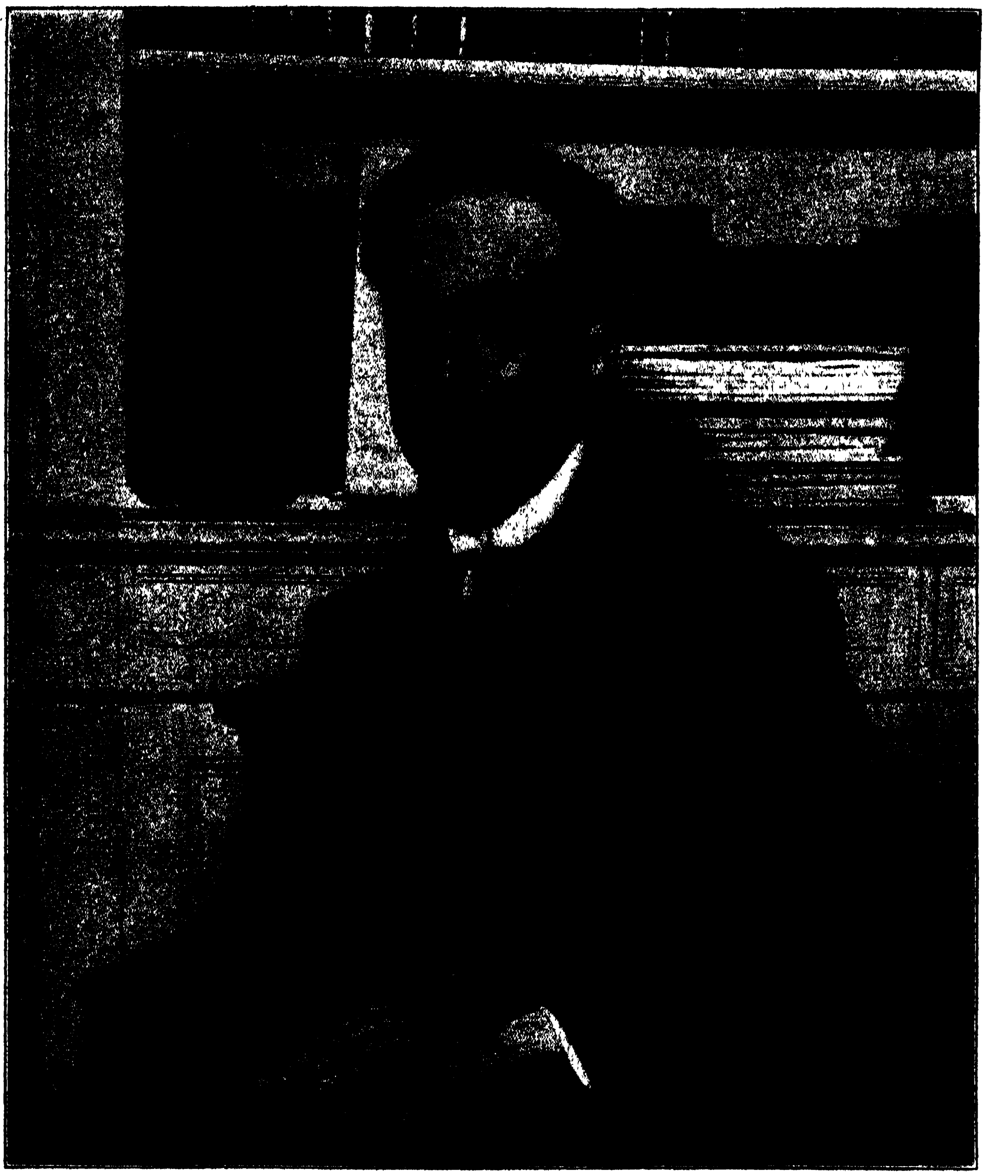
It resulted last year in the purchase, in 11 Southern California counties, of 48 percent of all new automobiles sold in the three Coast states. It has caused Los Angeles district to be chosen during the past 24 months as the location for West Coast factories by Goodrich, Firestone, Willys-Overland, Willard Storage Battery, Pittsburgh Plate Glass, Procter & Gamble, Crane, and National Lead Companies.

It is a factor to be reckoned with for it cannot be denied its objective. It is the fundamental of success...it is the spirit of Los Angeles County.

Industrial

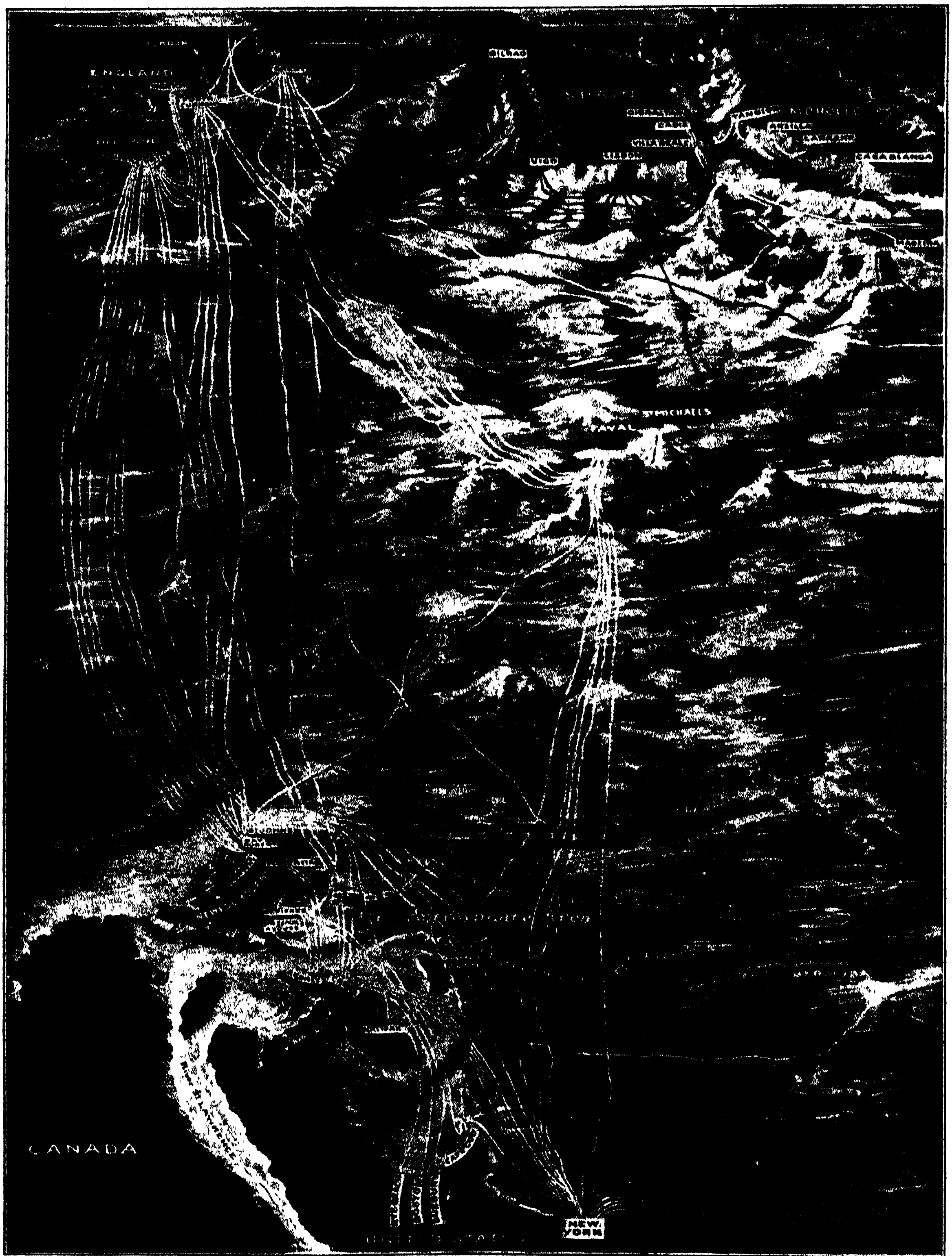
For specific surveys and detailed information regarding industrial opportunities, address Industrial Department, Los Angeles Chamber of Commerce.

LOS ANGELES COUNTY



Prince Louis-Victor De Broglie

TO Louis-Victor de Broglie, brilliant French physicist, younger brother of the X-ray physicist Duc Maurice de Broglie, is due the credit for first suggesting the new concept of the wave atom. Since his first publication of this revolutionary concept, it has been widely and frequently discussed throughout the world of science. Other capable workers, notably Schrödinger of Germany, G. P. Thomson of Scotland, (temporarily lecturer at Cornell University), Rupp of Germany, and Davisson and Germer of America, have taken it up and extended it until there is now a large literature, mostly abstruse, about the wave atom. For his original suggestion de Broglie has just been awarded the 1929 Nobel Physics Prize. What de Broglie did was to synthesize brilliantly some of the main concepts of physics which previously seemed contradictory. His hypothesis, as stated by the American physicist Heyl, "was that every mass-particle was enveloped and surrounded by a group of waves traveling with the particle as a sort of body-guard." Thus electrons, the fundamental basis of matter, have some of the qualities of particles and some of the qualities of light; matter becomes more shadowy, less material, and light more material, suggesting a kind of "merger" of previous concepts. The scientist de Broglie is also a nobleman. He was born in 1892. His great grandfather served in the War of the American Revolution as Gen. Lafayette's chief lieutenant.



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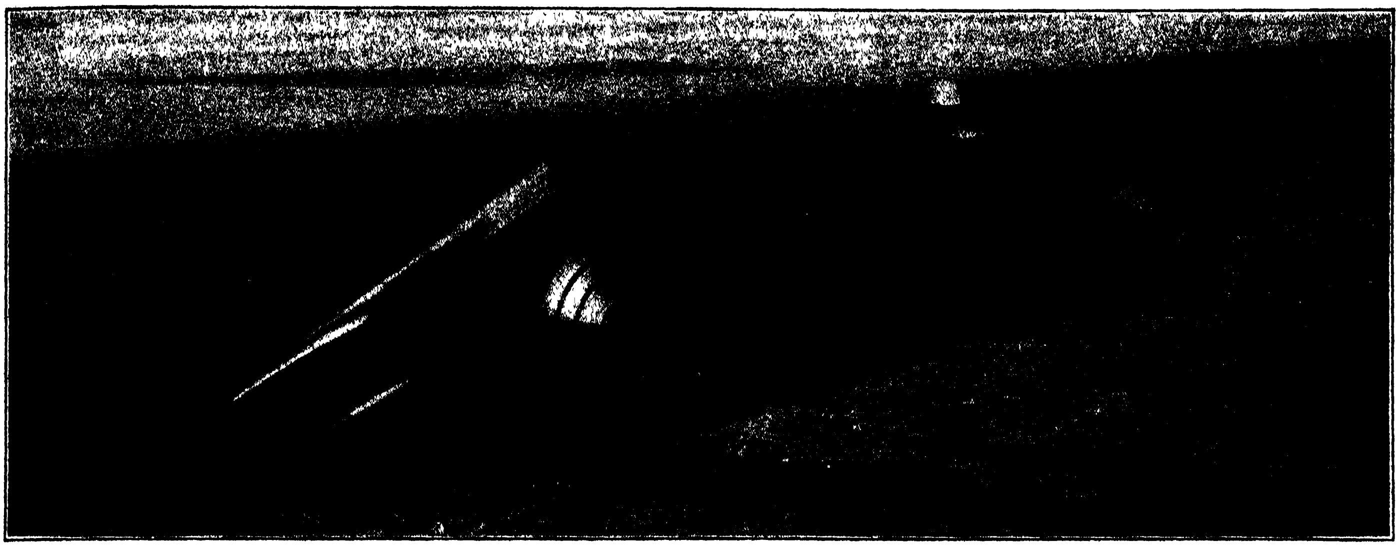
Submarine Cables and Area of Recent Earthquake

NEWSPAPER readers who were justly not satisfied with current, hasty explanations of the Newfoundland submarine earthquake will take interest in accurate data, necessarily delayed but dependable, communicated to the British scientific journal *Nature* by the noted Scottish geologist J. W. Gregory. The cable companies located 23 breaks in 11 cables. Plotting these accurately on a map, Professor Gregory saw that they were not haphazard but occurred in two north and south rows averaging 115 miles apart. New soundings between these rows showed that the sea bed had there actually dropped as much as 1710 feet, creating a great submarine trough. This is a new extension of the trough already existing between Newfoundland and Canada. Doubtless the rows of cable breaks mark two geologic subsidence faults,



PRESENT HOLDER OF THE WORLD'S SPEED RECORD

Designed and constructed abroad for the purpose of establishing a new world's record on the beach at Daytona, Florida, the *Golden Arrow* fulfilled its mission by raising the recognized speed record to 231 miles an hour. Sir Henry Segrave is shown in his famous car

400 Miles an Hour?

Far Greater Speeds Than Any Yet Achieved on Land Are Predicted by Sir Henry Segrave

By G. H. DACY

AUTOMOTIVE racing cars which will travel so fast that the human eye will be unable to record their passage are mechanical eventualities — speedsters on land which will outrival the swiftest aircraft that have been designed for cruising among the clouds.

That, at least, is the prediction of Sir Henry Segrave, owner and driver of the world's fleetest automobile, the spectacular *Golden Arrow* which was powered to attain a maximum speed of four miles a minute and which was timed at Daytona Beach at the unparalleled velocity of 231 miles an hour.

"What limit automotive speed?" was the question which the writer put to Major Segrave during a recent interview.

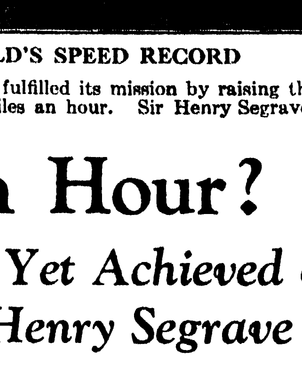
"THERE is practically no limit to the motor racing speeds which will be attained eventually," he replied, "provided that suitable speedways are available."

"Five hundred miles an hour?"

"That would make an astonishing lead for your story, now wouldn't it," Sir Henry countered, " 'Segrave says speed of 500 miles an hour possible.' I will not, however, qualify my statement by stipulating any limit to the future motor racing speeds. I am sure that the existing records are far below the marks which will be registered in the years to come."

"Master all phases of aerodynamic resistance," continued the former Ace, "as this is the salient factor which must be conquered in the consummation of thrilling flights in automotive vehicles on land, and our racing records will get better and better year by year. Improving the mechanics of motor cars for the attainment of ever-increasing speeds is easily possible. Even today, experimenters are able to build automotive power plants which will develop such amazing speeds that there are no speedways safe for the testing of such machines at peak velocities. We can now build machinery qualified to turn at more revolutions per minute than such mechanical parts ever moved previously.

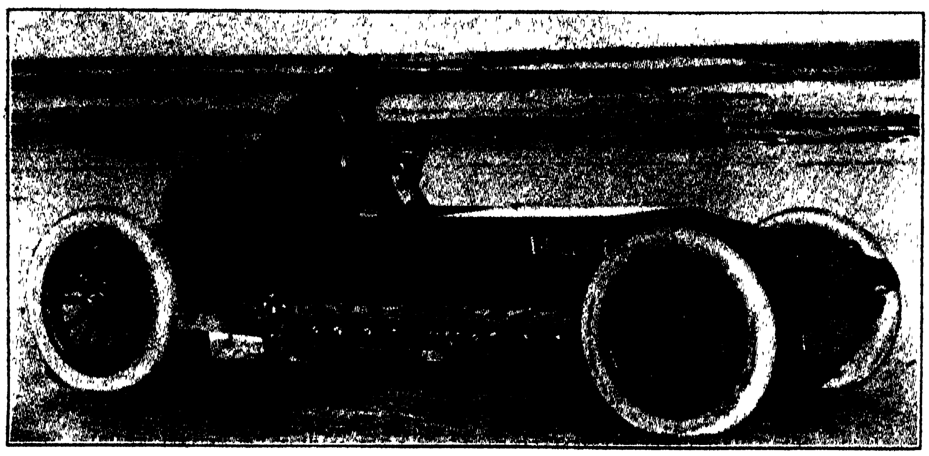
"Among other problems which must be solved before future cars are perfected and raced, at speeds faster than the velocity of the most devastating hurricane, are those which may appear to be insurmountable but which can be answered if enough technical research and money are devoted to such purposes. One need is the provision of either a natural or artificial speedway which will permit of time-trials at speeds of five miles a minute and faster. Such a course must be both smooth and compact. Daytona Beach, for example, would have to be lenthened considerably and measurably improved for such amazing trials against time. Car design must be improved so that air resistance is reduced to the minimum. Tires, either of rubber or some better material, will have to be constructed which will resist the disruptive action and tremendous heat of terrific speeds."



SIR HENRY SEGRAVE

To most of us who drive automobiles, and feel as though we are flying when we travel at the rate of a mile a minute, the predictions of the famous English aviator and sportsman sound almost incredible. Yet a review of the records in racing automobiles against time from the dawn of the sport in this country up to the writing of this article endorses Sir Henry's presages. Scan the ever-mounting records at Daytona Beach, the Indianapolis Speedway, and other national and international rendezvous of racing if you doubt this.

A certain W. J. Morgan, who chaperoned the first American bicycle racing team to Europe, is really the father of automotive time-trials in these United States. Mr. Morgan gained the co-operative aid of W. K. Vanderbilt, A. F. Vanderbilt, Howard Gould, and John Jacob Astor and introduced motor racing at Ormond and Daytona Beaches, Florida. The historic Vanderbilt cup races were a

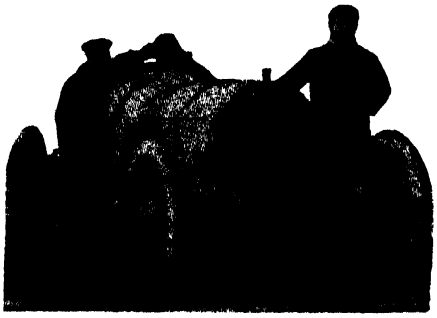


ESTABLISHING A RECORD IN 1903

Alec Winton driving the *Bullet* at the record speed of 69.18 miles per hour. This achievement, made at Daytona Beach in 1903, stimulated great interest in automobile racing

result of those early efforts to establish record speeds on "cushions of air."

Henry Ford, who was then an ambitious mechanic endowed with meager financial assets but aflame with the automobile racing urge, eventually came to Ormond with his homespun racer, notable *999*. Mr. Ford had expended most of his funds in the building and equipping of his "gasoline chariot." He was unknown in motoring circles. It was with great difficulty that he procured on credit fuel, oil, and other supplies for his racing machine. He never established any remarkable records at Daytona Beach although the story goes that in one of his speed trials, Mr. Ford equaled the one-mile time record of 39 seconds made in 1904 by Alfred Vanderbilt driving a Mercedes—a velocity equivalent to 91.8 miles an hour. In this feat, the body of *999* failed and Mr. Ford was forced temporarily from the racing game.



AN EARLY MERCEDES

With this car, Alfred K. Vanderbilt established a new record in 1904, by traveling a mile in only 39 seconds

VICTOR DEMOGOET, a French driver of a Deracq car, two years later increased the Daytona speed mark to two miles a minute by covering that distance in 58 4-5 seconds. Several years later, Frank Mariott piloted his Stanley Steamer over the same course at the gait of one mile in 28 1-5 seconds.

"Speed, speed, and more speed," was the demand of the rapidly developing automobile industry. Cars were shipped from all parts of America and Europe to the Florida beaches where drivers dared death in exciting efforts to shave fractions of a second from time marks. Some of the pilots risked their lives in pre-sunrise races against time. Roaring, gas-actuated vehicles of wood and steel hurtled through space, challenging the wind's maximum velocity and the efforts of their rivals to surpass their thrilling speeds.

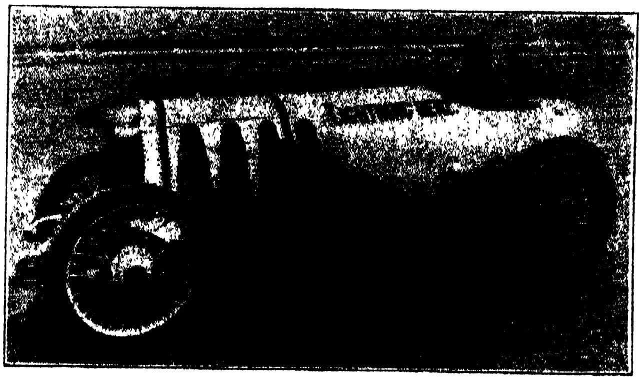
The beach at Daytona, composed of disintegrated coquina rock and ordinary sand, wave-rolled and water-packed, defies duplication as a natural motorway. It is so compact when the tide is out that race horses develop pavement soreness when run there. Early attempts to popularize horse-racing on that beach failed because all the equine sprinters soon became crippled due to the hard track. Rubber tires have absorbed the concussions which wrecked four-legged horsepower and as a result the endless story of speed conquests is being written in serial form.

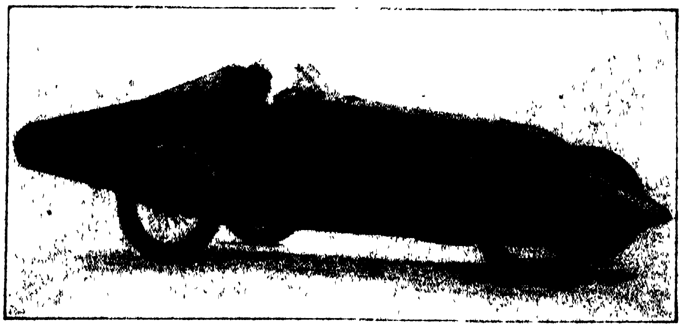
Ralph De Palma piloting a Packard in 1919 drove 10 miles in four minutes 9.31 seconds and subsequently lowered the mile mark from a standing start to 38.8 seconds. The following year, Tommy Milton driving a Duesenberg did even better by negotiating one mile in 23.07 seconds, five miles in two minutes 0.4 seconds, and one half a mile in 11.57 seconds. Milton's fastest speed was at the rate of 156.4 miles an hour. Subsequently, Joan Lacoste, a venturesome woman driver, drove a Miller at a gait of 144.65 miles per hour which still stands as the speed record established by her sex.

It was Sig Haugdahl crouched low at the wheel of his *Wisconsin Special* who ushered in the new era of speed at Daytona Beach. Haugdahl was timed in 1922 by officials of the International Motor Contest Association at the then almost unbelievable speed of 180.27 miles per hour, slightly better than

BARNEY OLDFIELD

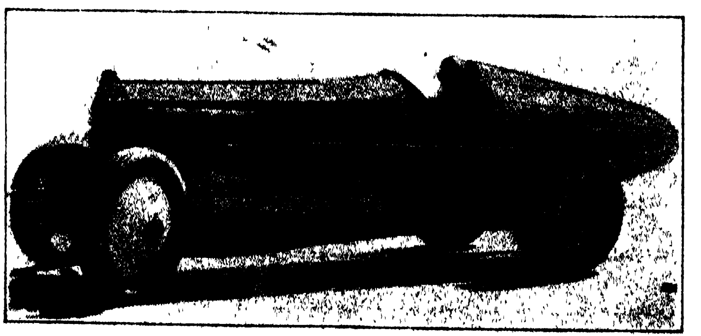
Driving *Lightning Benz* in a competitive race with Alfred K. Vanderbilt, the famous Barney Oldfield won one of the first of his many racing victories





TOMMY MILTON IN A DUESENBERG

In 1919, Tommy Milton introduced a new era of speed, when he drove this Duesenberg 156.4 miles per hour on Daytona Beach



RALPH DE PALMA DRIVING A PACKARD

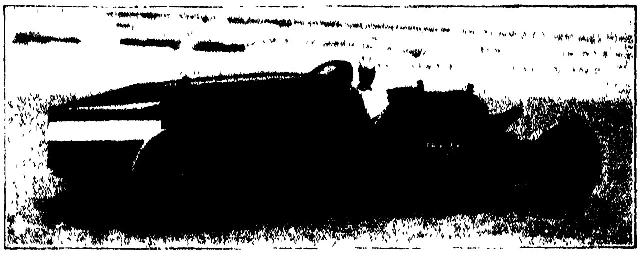
New records for various distances ranging from five to 20 miles were made in 1920 by Ralph de Palma, driving this Packard three miles a minute. A lull in racing records occurred until Major Segrave first visited Daytona Beach with his *Sunbeam Special.* A few days later, the former British birdman raced against electric timers at a speed of 203.79 miles per hour. He was the pathfinder among modern motorists who drive at velocities three times faster than express trains.

Then followed another Englishman, Captain Malcolm Campbell, winner of the Paris Grand Prix motor race over a cross-county course of 276 miles. Captain Campbell, seeking the crown worn by his countryman, unloaded his *Bluebird Special,* tried out the course and shortly shattered the record by covering a carefully measured one-mile stretch at the terrific pace of 206.95 miles an hour. Shortly afterward, Ray Keech driving the White *Triplex* increased the time trial mark to 207.55 miles an hour. During one of these trials, the tachometer in the White car showed that the machine was traveling at a velocity of 253 miles an hour. Over the same course, Frank Lockhart drove to his death. Officials estimated his speed at 235 miles an hour when his tires exploded and the car dove 15 feet into the air and 50 feet out to sea.

TIMING DEVICE

Speed trials on the beach at Daytona are clocked with this electrical timer

During the 25 years from the Alfred Vanderbilt record of 91.8 miles an hour to the acceptance of Sir Henry Segrave's mark of 231 miles an hour, the speed of the finest racing automobile has been increased 139.2 miles an hour. If this achievement is duplicated during the next quarter century, it will mean that the champion racing driver of 1954 will set a record of at least 370.2 miles an hour, better than six miles a minute. Sir Henry, who knows more about the design, operation and, driving of high-speed motor cars—both from theoretical and practical standpoints—than any other living driver, believes that a speed of approximately 400 miles or faster will be a reality within perhaps the next decade.


THE TRIPLEX

This ill-fated racer once placed the world's speed record at 207.55 miles an hour, with Ray Keech driving

SIR HENRY SEGRAVE maintains that with the eventual building of superhighways in the United States, and with future perfections of the ordinary motor car, American motorists will travel at speeds of from 100 to 150 miles an hour during their cross-country tours with as great safety as they now journey at 45 miles an hour. He says that at present there are ten makes of cars built in England which can do 100 miles an hour or better on present tracks and the finest roadways.

The motive power for potential passenger cars which in many respects will resemble the famous *Golden Arrow* is merely a matter of mathematics and is the easiest problem of all to solve in speeding up America's traffic streams. Both state and federal agencies have reacted favorably during recent months to higher speeds in the open country. California, for example, has abolished speed laws and leaves it to the individual driver to determine what speed is safe for his car and associated traffic. Research is ascertaining what special hazards are to be avoided at great vehicular speeds and thus is eliminating the dangers from future cross-country velocities of more than 100 miles an hour.

Sir Henry says that many improvements still remain to be made with regard to the aerodynamics of racing automobiles, as well as those of the passenger cars which eventually will be designed along similar lines. The future will see a much lighter-powered machine surpass the record of the *Golden Arrow* simply because experimenters will improve its aerodynamical features. Even today, the research experts of the National Advisory Committee on Aeronautics are experimenting in the wind tunnels at their Langley Field (Virginia) laboratories with velocities up to 1000 miles an hour. Their remarkable tests indicate future airplane and automobile speeds from three to five times greater than those which now prevail.

With the inevitable advances in road construction and in the mechanical perfection of automobiles, who can say what the harvest in the way of new speed records will be in the next quarter century?

SEGRAVE'S *SUNBEAM*

For his first American tests, Segrave used the *Sunbeam*, shown at the right

CAPTAIN CAMPBELL'S *BLUEBIRD*, FORMER RECORD HOLDER

For a short time, this English car held the world's speed record, at 206.95 miles per hour

OUR POINT OF VIEW

Science Awaits

WHETHER or not the general reading public is to believe that Professor Dayton C. Miller, the physicist who during several years past has been re-performing at Cleveland and Mount Wilson the famous Michelson-Morley ether-drift experiment and obtaining with uniform consistency indications of an actual ether drift and hence the existence of an ether, is out to "get" the Einstein theory of relativity which dispenses with an ether, seems to depend upon what it reads. If one could safely depend upon all he saw in the newspapers, and especially in newspaper headlines, Miller, driven by some animus, had about succeeded at last in hamstringing Einstein.

Quite a large section of the public has apparently become somewhat "steamed up" about these things and the Einstein—anti-Einstein battle has again taken on new life. We can think of no corner of science which seems to stir up as much high-pitched emotion as the Einstein theory. People for the most part are all for it or all against it; there is no middle course. It would seem that the most redoubtable defenders of the Einstein concepts come not from the ranks of the professional scientists but from the lay public; and likewise its most bitter and tenacious opponents.

One who goes habitually among professional scientists will not, however, meet with a comparable temper. There, instead of taking the matter in high gear, there is a marked disposition to take it in low. Perhaps scientists, or at least physicists and astronomers, the scientists most closely involved, realize a little more fully than others that the Einstein theory will not be settled finally one way or the other either by the research of any one man or two men, or even ten; or in one year, or two years, or ten years. Instead, a long slow pull is ahead and these men propose to take it in low gear. Animus, prejudice, personal feeling and, in short, any kind of emotion whatever is wholly contrary to the method of science. Let the layman if he wishes become overwrought about the reasonableness or unreasonableness, the demonstrability or sheer ridiculousness of bent space and similarly bizarre Einsteinian concepts; a good scientist will divest himself as completely as a Supreme Court Justice of every shred of such impediment.

Of all scientists there are two who give perhaps more clearly than any others the impression of living up to the scientific ideal—the search for truth unprejudiced—and these are Einstein and Miller. Let a world of blind admirers and enraged detesters of a theory beat the air with superheated syllables, Einstein serenely smokes his pipe and says "If Professor Miller's research is confirmed, my theory falls, that's all." And Miller, standing before his assembled peers in science, is almost apologetic about his findings but indicates that there they are. He has followed the lead of experiment, the only lead worth following. No wonder he receives a hearty handclasp from all men of science.

Rioting for Science

SINCE the world-famed trial of a Tennessee professor several years ago for teaching the theory of evolution, science has made great forward strides both in achievement and in the amount of serious interest it has aroused. But no one was surprised more than the scientists themselves at the scene enacted recently in the American Museum of Natural History, New York City, when a mob of 3500 to 4500 men, women, and children attempted to gain admission to a small hall in which was to be shown a moving picture concerning Einstein's theory of relativity.

Surging and seething around exhibits of the Alaskan Eskimo and the North Pacific Indian —canoes, totem poles, walrus tusk ornaments, kyaks — the swarming knowledge seekers were oblivious to these exhibits of which they already were informed and pressed on toward their objective — the higher knowledge of modern scientific theory. Theirs was no apathetic interest but a determination to learn. And while their rioting was undignified, perhaps, the mere fact that they did riot indicates that the popularization of science is now getting a stronger hold on average people. They *were* average people for they evidenced the psychology of the mob.

In the face of such facts, can skeptics continue to scoff? We think not. We believe that even the hard-shelled ones will begin to see the light, will begin to understand that despite dogma, superstition, and in-bred tradition, the appetite for scientific knowledge is becoming keener every day. SCIENTIFIC AMERICAN'S task of interpreting and popularizing science is, therefore, far from hopeless—except, of course, in the case of Voliva, dictator of Zion City, Illinois. We never hope to prove to his satisfaction that the earth is a sphere—but then, who wants to argue with him or his kind!

For misleading the public about the Einstein theory, first with regard to its alleged full acceptance by scientists and then with its alleged disproof by Miller, the popular writer is mainly to blame, for he too frequently presents snap judgments and half truths. Science itself takes neither course; it awaits. That is why this journal has published so little about the Einstein theory in recent years.

Bad Bargains

IN parts of the country where spring comes early, farmers and home gardeners are already buying seeds and doing their planting. In other sections, many thousands of people are poring over seed catalogs, fascinated by the size and colors of the fruits, flowers, and vegetables depicted there in all their glory.

Most of these people are experienced. For some of them, farming or gardening is a life work but for a lot of others these jobs constitute an avocation or a method of obtaining recreation and exercise. Yet despite their experience, many planters buy their seeds according to price. They are warned year after year to buy the very best seeds available and are reminded that cut prices indicate inferior seeds, the purchase of which is the poorest sort of economy. And yet many catalogs replete with alluring promises and splashes of color are published every year by unscrupulous dealers and have a wide circulation.

Therefore, for your own best interests, heed the perennial warning: "Don't buy bargain seeds!"

Increasing Game

A FEW years ago it was feared that the American buffalo, or bison, was doomed to extinction. Then the government took a hand and protected the few remaining specimens, with the result that herds are rapidly growing. Now comes the good news in an announcement of the Forest Service that large game animals, indigenous to America, are also showing an increase in numbers. To most people the figures, based on very careful estimates, will be surprising.

On December 31, 1928—the latest estimate available—deer on the broad expanses of our National Forests had shown an increase over the preceding year of 47,400, making a total of 748,000; elk increased from 74,200 to 78,-

200; and antelope from 7700 to 8500. On the date of estimate, black or brown bears totalled 52,200; grizzlies (including the Alaskan brown bear) totalled 3400; mountain goats, 19,300; and mountain sheep, 13,800.

These game animals have not been press-agented as much as our buffalo, to which a great deal of sentiment has been attached due to the important part it played in our history, but they are valuable nevertheless and certainly worth all the effort expended in their behalf. It is to the credit of the Forest Service, therefore, that it has undertaken to increase the supply of game animals—even to the extent of "planting" them in sections where they have been exterminated. And if it can devise means of increasing the number of moose, caribou, and mountain goats—the three important species which are hardly holding their own—the Forest Service will win the thanks not only of naturalists, nature lovers, and big game hunters but also of those sentimentalists who have a predilection for all early American things.

Our Limitation Conference Delegates

THE difficulties confronting the delegates attending the Conference on the Limitation of Naval Armament in session at London, are obvious to the most casual observer. It is never easy to reconcile the naturally ambitious aspirations of first-rate powers. The rôle of an envoy is always an unhappy one; if he abates too much of his country's claim he is assailed as unpatriotic; if he is too chauvinistic he prevents an international accord.

Our country has no traditional enemy or unsatisfied ambition. It is financially able to indulge in competitive naval building if that becomes necessary, but prefers to concentrate its energies in peaceful pursuits and well knows that its real interests will be furthered by an era of world peace. Nevertheless, the international situation is so complicated by the relations existing between other states, and Europe has such a heritage of conflicting ambitions, that our delegation will be taxed to find an agreement, satisfactory to all the powers, that will still safeguard our own legitimate interests.

Mr. Hoover has from the first been aware of these difficulties; his years abroad familiarized him with the unending struggle for foreign markets, scarcely suspected in some parts of our country; he knows that a desire for peace will not of itself keep a country out of war, and what he saw in Belgium under German control will not incline him to expose his country ever so remotely to such horrors. He has stated that he will not attempt to lead the world to disarmament by solitary example.

To confront and assist in overcoming these difficulties, Mr. Hoover has selected an extraordinarily strong delegation of civilians and has supplied them with able naval advisers. During the World War three of the civilian members—Mr. Stimson, Mr. Dawes, and Senator Reed—served in France in the American Expeditionary Force; Mr. Gibson served in the American Embassy at Paris; Mr. Morrow served on the Allied Maritime Transport Council. The presence of Senator Reed and Senator Robinson insures the Senate complete information on the proceedings, and the participation by Secretary Adams assures the country that the efficiency of the Department assigned to his care will not be unduly sacrificed. The following brief sketches of the personnel of the American delegation emphasize the careful selection exercised by our President, and we feel sure all Americans will wish them well in their efforts to find a proper solution to an ancient problem.

The Barjot Plan and a Greater North

TO the engineer and the practical man the Barjot power project described on page 196 will be seen to resolve itself directly into a question of economics and engineering installation. Its purely theoretical or scientific side is sound, being based on simple elementary physical laws; it takes advantage of a temperature difference. This, also, is the essence of a steam plant; heat is energy. In the Barjot scheme, however, the temperature difference is relatively small, but the volume of the "fuel" available is sufficient to compensate for it—far more than sufficient, in fact.

To some readers the apparent lowness or coldness of both of the temperatures involved in Dr. Barjot's plan, the low and the high, may seem to be an obstacle. It must, however, be remembered that the coldest arctic temperatures are not in actual fact low. What we human beings commonly think of as "low" and "high" temperatures have no such significance in science; they are merely relative to our own immediate criterion of hot and cold, the reports of our senses. Zero on our Fahrenheit scale is actually 459 degrees above zero on the absolute scale of temperature—two thirds of the way to the boiling point of water—and that is the only scale which has inherent sanction in fact. The rest are arbitrary; and misleading, also.

The Barjot plan bears close resemblance to the well known Claude-Boucherot plan for making use of the temperature difference between tropical sea water at the surface (80 degrees) and at the bottom (40 degrees). Both are fundamentally based on taking advantage of a temperature difference. Extensive application of the Claude-Boucherot plan would spread the industrial world from the temperate zones, where it is now centralized, to the tropics; the Barjot plan would spread it far toward the Arctic. In this connection one will recall the writings of the arctic explorer Stefansson, in which he has so often emphasized that the north will some day cease to be regarded as a vast arctic waste and become the object of a very active exploitation. Canadians should be especially interested in Dr. Barjot's article.

Mr. H. L. Stimson, the head of the American delegation, a New Yorker by birth, a graduate of Yale College and Harvard Law School, was a law partner of Elihu Root and, like him, served as Secretary of War before serving as Secretary of State. During the World War he served in France in the Field Artillery and earned his promotion to Colonel of the 31st Field Artillery in the field. He succeeded Leonard Wood as Governor General of the Philippines and carried on his work of rehabilitating the Philippine Government. Although a strong executive and frequently in conflict with Filipino politicians, Mr. Stimson quickly gained the confidence of the Filipino people and on his departure from Manila to become Secretary of State he was given a farewell ovation by the inhabitants of Manila.

Mr. Stimson belongs to that group of eastern Republicans most favorable to our entry into the World Court. There can be no doubt of Mr. Stimson's abilities to present America's just claims to parity; he is too wise to be imposed upon, and although this is his first large undertaking as Secretary of State, we venture the prophecy he will not let his natural desire to return home with an agreement lead him to make concessions that will be unacceptable to the Senate or the country.

Mr. Charles G. Dawes comes from the Middle West that boldly claims it represents the heart of America; he graduated in law only to become a successful banker and business man. He served on Pershing's staff during the World War and, as a member of the Liquidation Committee of the A. E. F., closed out the vast mass of unfinished business between the United States and France in one big bargain with the French in 1919. It was his spirited defense of the work of this committee before an investigating committee of Congress, that brought him nation-wide attention and added "Helenmaria" to the American vocabulary. He organized the Office of the Budget for President Harding, but soon turned over the job to General Lord and returned to his business.

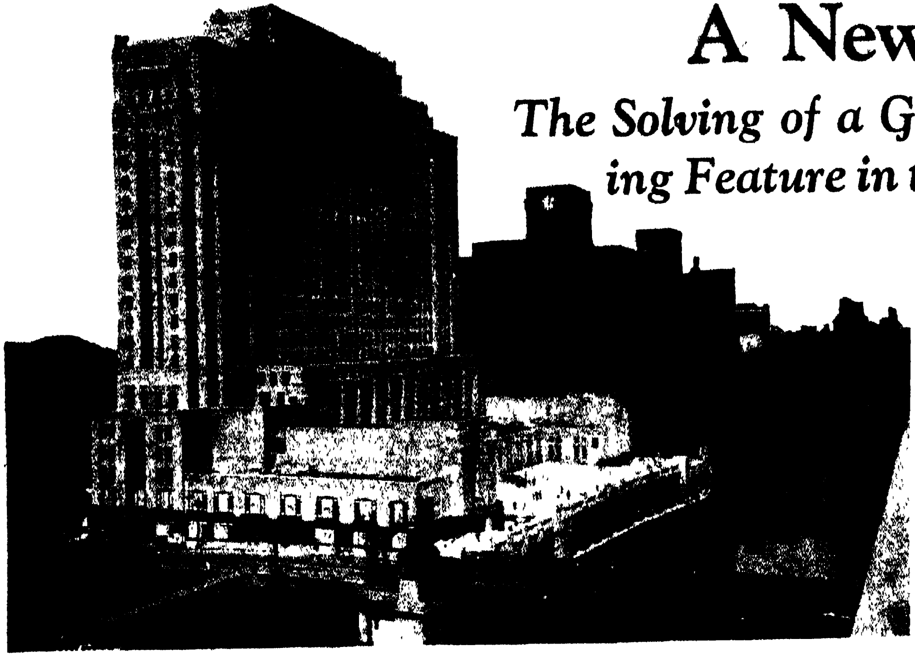
But for his loyalty to Governor Lowden, he would have been a more formidable candidate for the Republican nomination for the Presidency in

(*Please turn to page* 246)

A Newspaper in the

The Solving of a Great Railroad's Smoke ing Feature in the Creation of a Huge

By ALBERT A. HOPKINS



THE MONUMENTAL BUILDING

This huge building is built astride railroad terminal tracks. The smoke from the track area passes through vents into smoke chambers and is carried up a great internal chimney

CHICAGO needed to expand. That iron bound "Loop" held the business quarter in a vise. There was congestion and lack of space for growing industries. The freight tunnel helped to relieve the situation, but something more had to be done to give relief. What did Chicago do? They turned to their river, which was heretofore a hopeless nuisance upon which the city's back must be turned, and they found that it had other uses than as a receptacle for wastes and as a means of transportation of freight. The Wacker Drive development and the new Marshall Field Building on the main branch of the river, and the Union Station, the Civic Opera, and The Daily News buildings on the south branch all testify to the growing realization that the river is a civic asset of primary esthetic importance.

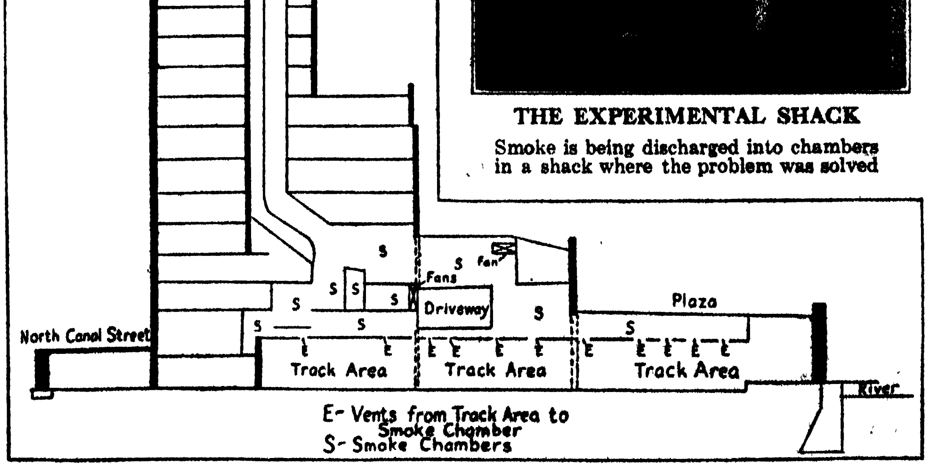
THE completion of the Daily News Building above the tracks of the Union Station group of roads and the rapid progress of work upon the Merchandise Mart above the Chicago & Northwestern tracks should serve to give a concrete object lesson relative to the hundreds of millions of dollars of value and income which railroad officials could produce for their stockholders by prompt action in making possible air-rights development above their terminal tracks. But what about the smoke? There did not seem to be much chance of electrification in the Chicago region, so this question became a very vital one.

The smoke problem was attacked and solved in an interesting manner by Mr. Joshua D'Esposito, a consulting engineer. Today the Daily News Building is an accomplished fact, but only because of a new departure in the handling of smoke and gas discharges from locomotives. One admires the symmetry of the beautiful building but does not realize that hidden away from general view are certain chambers, passageways, and stacks which are the agencies of the smoke control system. The construction engineers understood the value of air-rights, New York furnishing an excellent example, but there the smoke problem has been solved by electrification. Smoke-handling tests in Chicago began early in 1917 in a temporary shack in the coach yard of the Pennsylvania Railroad. The experiments involved great labor and cost much money, but they were successful in the end.

An expansion chamber was constructed above the vents in the test shack. The engineers found a valuable fact in that the smoke in the chamber expanded. Expansion decreased its density, made it practically as light as air, and consequently added a safeguard against its dropping through the entrance passageways. The system was entirely successful. The Daily News Building was accordingly built directly over the tracks and the locomotives belch smoke and gas freely. These waste products pass through vents in the roof to the roomy

THE EXPERIMENTAL SHACK

Smoke is being discharged into chambers in a shack where the problem was solved



ELIMINATING THE SMOKE

The smoke is drawn from the expansion chambers into a smokestack that mounts through the 25 stories to the open air. The great bulk of the solids is stopped in smoke chambers

Making
Problem Was a Strik-
Newspaper Plant

MAKING AIR-RIGHTS POSSIBLE

The Chicago Daily News Plaza viewed from below. The grooves in the ceiling are the smoke vents which allow the smoke from the C. M. & St. P. engines to pass into the numerous smoke chambers directly over the track area, an excellent utilization of air-rights

smoke chamber which is as wide and as long as the track area. To be precise, this chamber consists of several divisions, as partitions have been built in it. The smoke is drawn from the expansion rooms into smokestacks that mount, through the 25 stories of the building, to the open air. The great bulk of the solids in the smoke are stopped and remain in the smoke chamber, to be removed later. Smoke emitted 25 stories up is as nothing compared with the same smoke emitted at or near street levels.

We need say little of the architecture of the building itself; it really has to be seen to be appreciated. It is one of the finest buildings in America and directly across the river and facing it is the new Civic Opera House illustrated in our February issue. The plaza, the bridge, the clocktower are all beautiful features. A fleet of speed boats take the visitor or the commuter via the river to the Wrigley Building on Michigan Boulevard in a few minutes.

The *Chicago Daily News* is one of America's great dailies, and while visiting the building the writer was so struck with the newness and efficiency of the great plant that it was determined to make the latter part of this article a brief description of the work involved in turning out a newspaper.

The *Chicago Daily News* was built up by Melville E. Stone and Vincent F. Lawson. Mr. Stone was for many years manager of the Associated Press and with Mr. Lawson as president they helped to develop this great cooperative news gathering and distributing agency. A newspaper has been well defined as an organism with a synthetic soul. While habitually giving reliable information in the fullest measure, it must endeavor consistently to teach a sound philosophy of life. It must be fair, avoiding prejudice and prejudicial practices. In the broadest sense it must be a force on the side of human progress. The *Chicago Daily News* has always held public confidence. This is probably the reason why it has such a splendid building.

THE NEWSROOM AT WORK

In the foreground are the rewrite men. The city desk is shown at the right center and in the background are still other desks

THE BUSY "COPY" DESK

Reports of the doings of the teeming world, received by wire and written by the reportorial staff are all edited and head lined

WAITING FOR THE LAST LINE

The markets have closed and the editors have finished their work on the "Red Streak" edition. In a few seconds the closing quotations will be in type and then to press and the street. As this is an afternoon newspaper, great speed is necessary in handling financial news

The old building at 15 North Wells Street was a ramshackle affair endeared to all those who were brought up in its atmosphere. For many years the talk of a new building had been the subject of many a joke. Site after site was considered and rejected. The

"WANT" ADS BY TELEPHONE
These alert girls take in "want" ads over the telephone for the classified advertising

development away from the "Loop," the construction of Wacker Drive, and the river straightening project all seemed to point to the necessity for a location where considerable space was available, yet one which was central enough for the receiving of news and for distribution of the printed newspapers. Therefore the site over the tracks next to the Union Station was finally selected.

A newspaper is an exceedingly complicated organization, particularly in the editorial end, and it requires great co-ordination. It will have besides the managing editor, an associate editor, news editor, art editor, editorial writer, literary editor, foreign news editor, the make-up editors, and special editors for sports, automobiles, aviation, financial, et cetera. These clever craftsmen all have their offices, but they lack the atmosphere of the newsroom, where are arranged the 45 desks of the city editor, the copy editor, telegraph and picture editors, the rewrite staff, and the reporters. A feature of the room is the specially designed copy desk which provides space for 10 copy editors and their chief. Of course there is ample telephone service as well as pneumatic tubes for routing communications. Copy boys, the descendants of the printer's devils of yore, are arranged along the north wall of the news room, where they can respond quickly to the calls of editors and reporters. Directly in front of their station is a slot in the floor through which copy is dropped to the composing room so that only a few seconds elapse from the time the copy is written until it reaches the battery of linotype machines.

AN EXPERT TOUCH
The foreman engraver has been putting finishing touches on plates since 1887

THE "HI-LO" ROOM
Priceless seconds are saved by putting market quotations directly into type. The girls read aloud from the unwinding tape and the compositors set type by hand. It is a mad rush

The composing room is 200 feet long and 80 feet wide. Here is installed a battery of 54 latest model linotype machines, besides other composing equipment. The composing room includes an engraving department and a matrix department, to name only a few of them. The room where the market reports are compiled is the scene of a daily fight against time. The quotations are hand set by compositors receiving the dictation of girls who watch the swiftly moving tape. The entire composing room is floored with wooden blocks placed on end which rest rather than tire the feet. The ceiling is covered with soundproof material which eliminates sharp and metallic noises.

The photo-engraving department allows for speedy production of both line and half-tone cuts. The newspapers are printed from curved stereo-

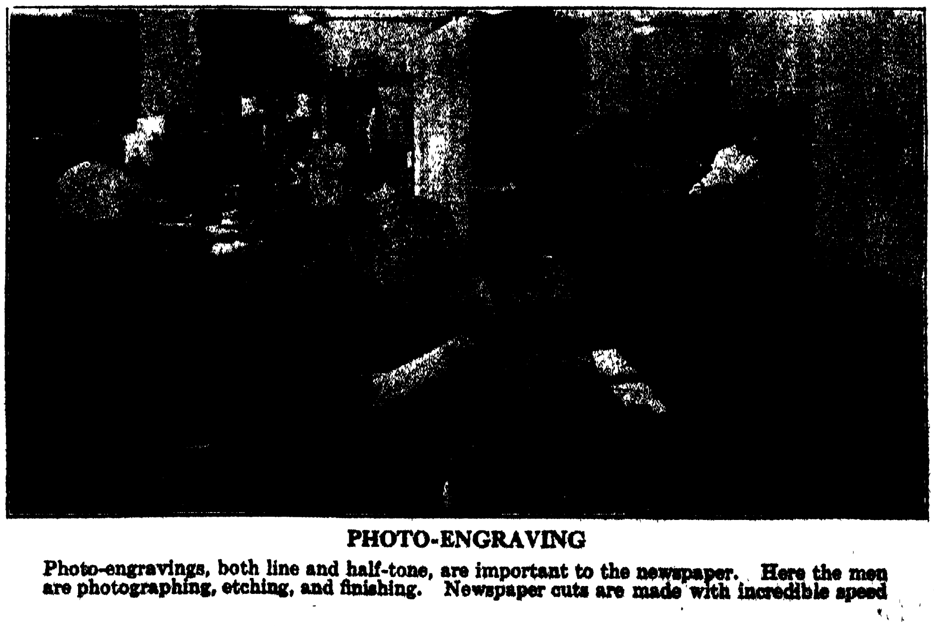


PHOTO-ENGRAVING
Photo-engravings, both line and half-tone, are important to the newspaper. Here the men are photographing, etching, and finishing. Newspaper cuts are made with incredible speed

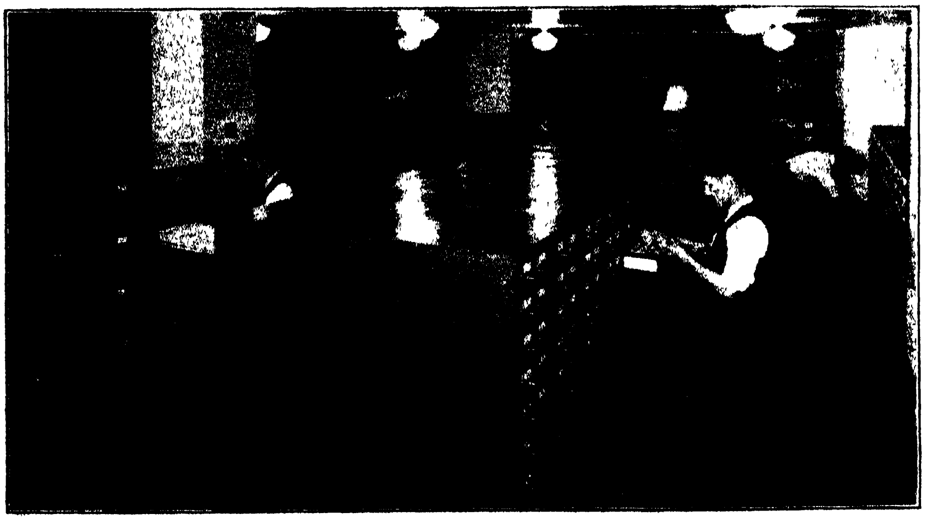
THE STEREOTYPE FOUNDRY ➤

Here the semicircular plates for the great presses are cast in wonderful automatic machines

type plates which are made in the stereotype foundry. These plates go to the great presses which are of very special design. One would hardly expect any sentiment to prevail in the pressroom, but when the order for new presses was placed by the publisher, Mr. Walter A. Strong, he suggested that the old metal be used. Carrying out his wishes, R. Hoe and Company, builders of the new units, melted down the old iron castings and used the metal for the new presses and folders. The presses consist of 70 units. Each unit has a capacity of eight pages, and units may be made up in tandems of from two to 10, depending on the size of the paper to be printed. Presses are carefully insulated to avoid vibration. They are floated on a mat of cork which is laid on a concrete base and up the sides of the press pits.

A crane moves the rolls of paper from the hold of the vessel on which they are delivered and places them on a conveyor system which operates down a mammoth shaft to a point 40 feet below the surface of the river. As the paper reaches the bottom of the vertical shaft, it is rolled off on horizontal conveyors and travels under the Union Station property, and the Chicago, Milwaukee & Pacific Railroad tracks until it is beneath the Daily News Building. Then it is automatically rolled off to a vertical lift where it ascends to storage space, or directly to the presses.

The paper in roll form is fastened on a roll in the press, its open end is smeared with glue, and as it is swung into place the open end flips over to the paper web going from the press and is automatically glued to it. The web from the old roll is broken and the new roll takes its place. It speeds through the press, being printed on both sides, and comes out on a folding machine where the individual papers are automatically cut apart, stacked and placed on the conveyor which brings them automatically to the binding machine which counts and binds them with wire into bundles of 25 or 50, depending on the size of the issues.

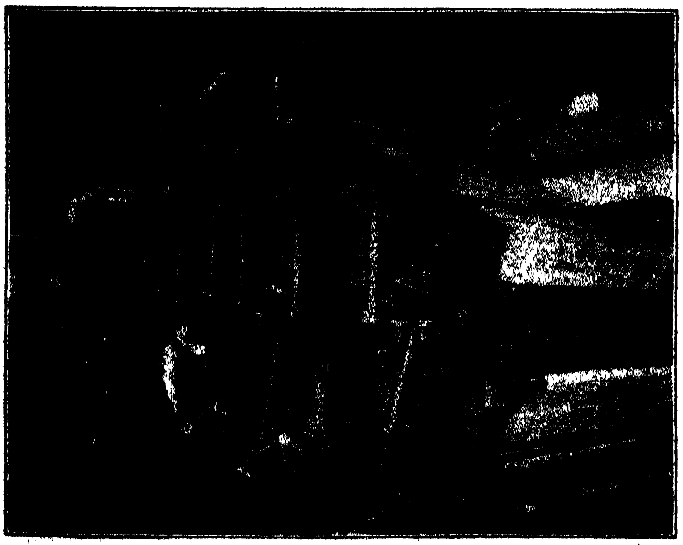


THE "MORGUE"

A million photographs, a million clippings, one hundred thousand negatives, form a part of the "morgue." It is easy to "look it up" here with such splendid modern equipment

Some of the figures relating to the pressroom may be found interesting. The mechanical equipment cost approximately 3,000,000 dollars. For an 80-page paper, 2000 plates of type are cast in multiples for speed. Nine thousand pounds of ink are used daily and more than 100,000 pounds of melted metal are required each day.

Many of our pictures are self-explanatory, such as the morgue, receiving of classified advertising, et cetera. The *Daily News* equipment includes two airplanes and a fully equipped broadcasting studio, station WMAQ.



CLICKING OFF THE "HOME" EDITION

The nine great presses have a capacity of 300,000 papers hourly. The complex machinery daily turns 300 tons of white paper into printed newspapers. They are the last word in printing machinery

A QUESTION OF INK

The proper distribution of ink is important. The superintendent of the pressroom is operating the ink-fountain supply regulator with a press-sheet before him to ensure even color distribution

Cameras, Airplanes, and a New Industry

The Story of an Inventor Who Developed a Hobby Into a Commercial Enterprise of International Standing

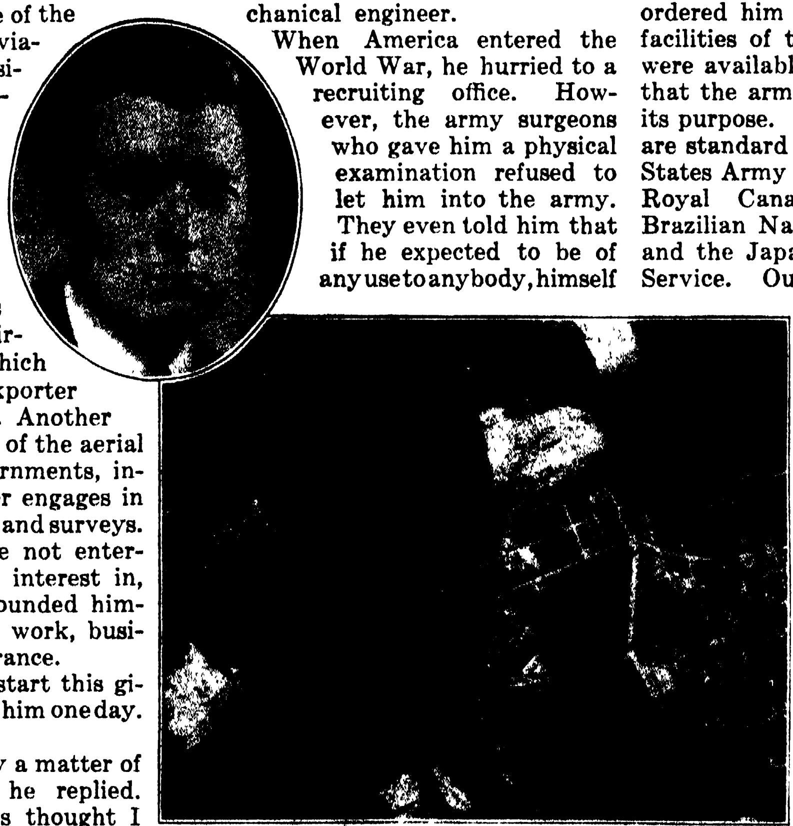
By MILTON WRIGHT

IN the history of American invention there are the names of plenty of poor boys who struggled over seemingly insurmountable obstacles to places of prominence. It almost would seem that lack of resources is one of the essentials of success.

Once in a great while, however, we find a man who lacks the advantage of having been born in humble circumstances, and who, in spite of that fact, makes an invention that founds a new industry. And when we do find such a man we have found one whose career it will be well worth while to study.

Consider Sherman Mills Fairchild. At 33 years of age he is one of the dominant figures in the aviation industry, being president of the Fairchild Aviation Corporation and a half-dozen subsidiary corporations, all bearing his name, as well as vice-president of the 200,000,000 dollar Aviation Corporation which he helped to organize. His companies control two airplane factories, one of which is said to be the largest exporter of cabin planes in America. Another of his companies makes all of the aerial cameras used by six governments, including our own. Another engages in making aerial photographs and surveys. And these, remember, are not enterprises that he bought an interest in, but enterprises that he founded himself and built up by hard work, business acumen, and perseverance.

"How did you come to start this gigantic business?" we asked him one day.



MAPPING THE EARTH FROM THE SKY

Typical aerial survey map, useful for realty development, taxation, and similar purposes. *In the oval:* Sherman M. Fairchild

"IT probably was largely a matter of natural perversity," he replied. "My relations and friends thought I was just wasting my time on what they considered merely a hobby, so I just had to show them they were wrong."

"But how did you come to take up aircraft?"

"Oh, that was a matter of evolution. One thing led logically to another. Of course, we had to have our eyes open to see opportunites when they appeared, but then the aviation industry is full of opportunities."

"You started in aviation in the war, didn't you?"

"No, not exactly; let's say at the time of the war."

Elsewhere we learned that Fairchild had adopted several hobbies. One was interior decorating. Another was playing the piano. Today he has two pianos in his New York apartment and two in his country home at Centre Island. His favorite form of relaxation is playing duets with a certain well known composer and music publisher.

The one hobby that has determined his career—and affected, too, the development of aviation—is photography. Cameras are a means of achieving artistic effects, and Fairchild is artistic. Their use involves niceties and intricacies of mechanical operation, and Fairchild is mechanically inclined; in fact, he is a mechanical engineer.

When America entered the World War, he hurried to a recruiting office. However, the army surgeons who gave him a physical examination refused to let him into the army. They even told him that if he expected to be of any use to anybody, himself included, he had better start living in a high, dry climate. So Fairchild went to Arizona, while all the other fellows his age—he was 21 then—went to Europe.

But you know what Emerson said about building a better mousetrap and the world beating a path to your door through the wilderness. Fairchild, in Arizona getting back his health, worked away with photography. More and more the war news featured airplanes. Not only were planes fighting one another and raiding enemy positions, but, what was more important, they were the eyes of the army.

Here was where Fairchild could help—aerial eyes for armies—cameras for use in airplanes. And cameras were his hobby. He went to work and soon obtained some remarkable effects in clear, sharp, long-range photographs. They came to the attention of army officials in Washington.

FAIRCHILD was getting results that the army couldn't get with the apparatus they were using, so they ordered him to Rochester, where the facilities of the Eastman laboratories were available. He evolved a camera that the army found ideally suited to its purpose. Today Fairchild cameras are standard equipment of the United States Army and Navy Air Corps, the Royal Canadian Air Forces, the Brazilian Navy, the Argentine Navy, and the Japanese Imperial Army Air Service. Our own Army Air Corps specifies that substantially all airplanes now being built must provide for the installation of Fairchild cameras.

"Just what did you do to perfect cameras for aerial use?" we asked Mr. Fairchild.

"Worked out the between-the-lens shutter," he replied. "If you will recall almost any picture of racing automobiles that you've looked at, you may remember how distorted the objects were and how uneven the illumination was. Those defects were due to the design of the shutter; you don't have them if the shutter is of the between-the-lens type, such as those used by the army.

"This kind of shutter, as we use it today, is adjustable to speeds of 1/50, 1/100, and 1/150 of a second. It is mounted in a metal cone attached to the camera body. The retard mechanism for varying the shutter speeds has to be positive in action and unaffected by changes in climate, for the army takes its pictures at high altitudes where the temperature is far below zero. We obtained a high efficiency in opening and closing the shutter by having the retard mechanism function only when the shutter leaves are wide open; it is released before the leaves begin to close."

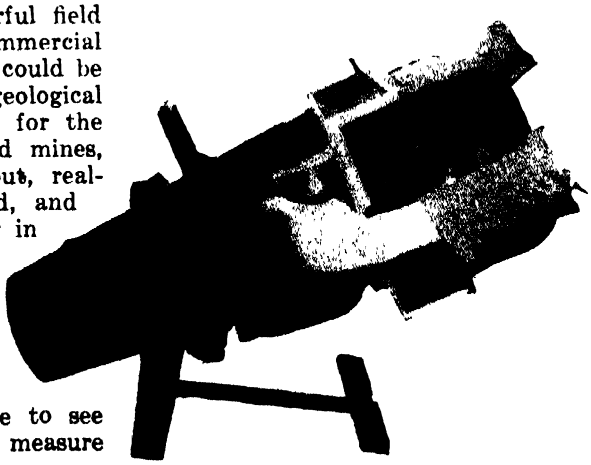
"But how did you step from cameras to airplanes?"

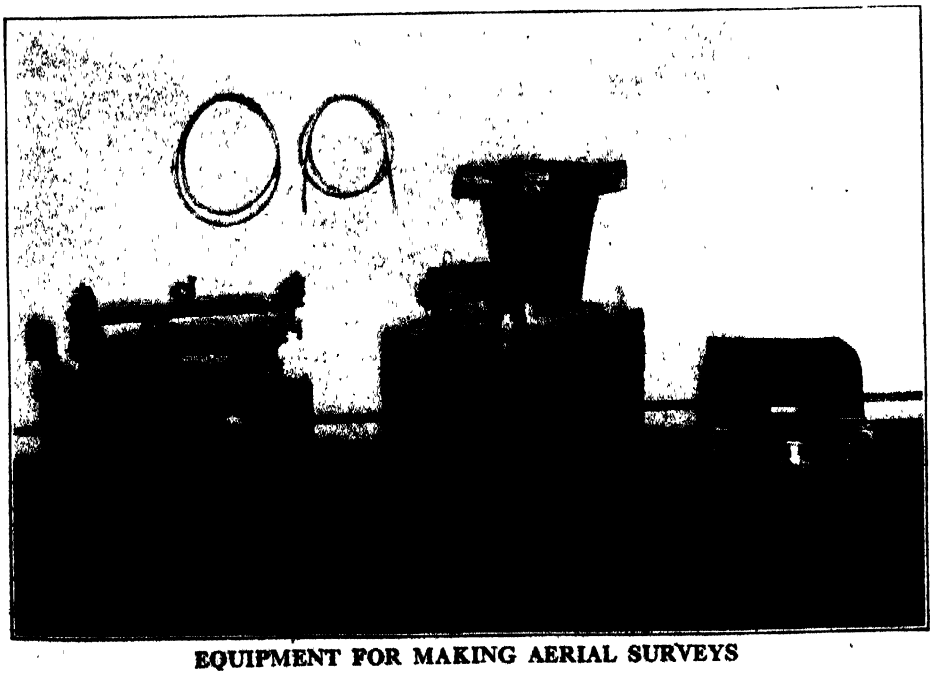
"The planes came later. The army wanted cameras, and so we started making them. We're still making them, developing new models, of course, all the time, for the art of photography is one of constant progress and development. Some remarkable results are being obtained. Only recently Captain Stevens of the army took pictures at a distance of 227 miles. [See page 127, February.]

"RECENTLY we received an order from the army for a machine gun camera; it looks and is operated exactly like a Browning machine gun, only instead of shooting cartridges, it snaps pictures which show the accuracy of the aerial marksmen. [See page 482, December 1929. Editor.]

"To develop aerial cameras we had to use them, and, using them, we came to see what a wonderful field aerial photography was for commercial and industrial uses. Towns could be surveyed for tax purposes, geological formations could be studied for the location of oil wells or gold mines, power sites could be laid out, real-estate developments planned, and the like. The hardest thing in connection with this was educating the public. Nobody had ever used aerial photographic maps and it was an uphill job to put them over.

"As we did more and more aerial survey work we came to see that results depended in a measure upon the kind of airplane we used. A plane for photographic work ought to be stable and steady, comfortable, fast, and easily maneuverable. There was no plane that we considered ideal.





EQUIPMENT FOR MAKING AERIAL SURVEYS

Aerial camera outfit, with swivel mount, intervalometer, and magazine containing 75 feet of film. *Above:* Camera assembled on swivel mount in position for mapping from high altitudes

"We were down at Rio Janeiro equipping the Brazilian Navy with aerial cameras, when their officials asked us to get them a plane. This was our opportunity. We would sell them one that would incorporate our own ideas. We had another manufacturer make it for us. The Brazilian Navy liked it, but we could have done better if we had made it ourselves.

"We designed a new ship and built it. We entered it in the Ford reliability tour and it outperformed other ships in its class. Within a year we had sold several planes of that design to other companies who were engaged in the operation of aircraft or were manufacturing exclusively for the government."

"But how did you get a factory?"

"At first we rented the old Sperry Gyroscope plant at Farmingdale, Long Island. Later, as we grew, we bought land and began putting up factory buildings of our own. As business developed we kept adding to them."

MAKING AERIAL PHOTOGRAPHS

Photographic mapping from the cockpit of an airplane, with the camera in position

"But how did you come to go into a big combination of airplane companies?"

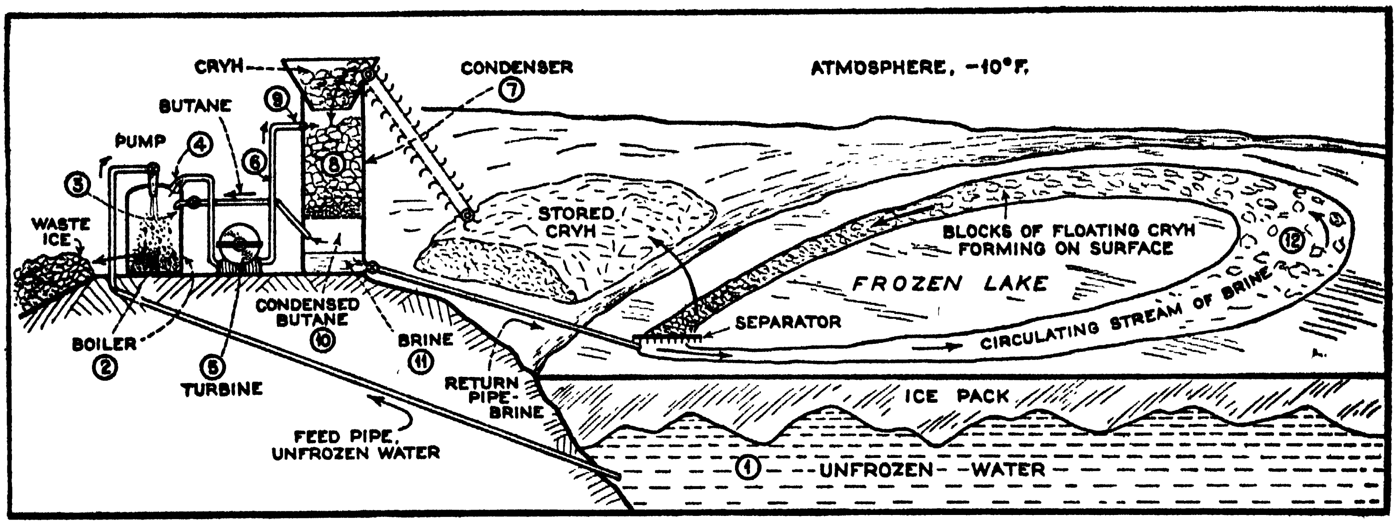
"This is the day of big combinations; especially is this true of the aviation industry. It is all very well for an inventor to start out in a small way and keep going by himself, but only up to a certain point.

"WITH the camera we had exclusive patent rights and the capital investment required was not enormous. When we got into airplane manufacturing, a small group of men was enough to provide all the funds necessary. Later, as we expanded, we enlarged our group of owners. Then came the day when we saw the need for a sort of 'General Motors' of the air. We organized the 200,000,000 dollar Aviation Corporation, with the Fairchild Aviation Corporation as its manufacturing unit. Other combinations were forming, and we had to do it, too, not only as a defensive measure, but as a means of contributing to the advancement of aviation."

"Do you still do much inventing yourself?"

"Not a great deal now; there are too many other things to do. I probably have had 50 or 60 patents issued in my name, but nowadays the design of airplanes and engines has become so highly specialized that we retain the best engineering talent we can find. The inventor may be all right for supplying fundamental ideas, but in a highly technical field like aerodynamics you want a highly trained specialist—a scientist.

"Then, too, you must remember that after you reach a certain stage of development, your job is not alone one of inventing, nor even of manufacturing. You must know the whole field in which you are operating, you must read in the activity of today the developments of tomorrow, and you must organize your forces accordingly."



A DIAGRAMMATIC LAYOUT OF THE PROJECTED INSTALLATION

The numbered details are listed in the text and will be better understood if left until their description is reached. It would be well, however, to take note of the main features, the feed pipe and the source of its supply beneath the ice, also the return pipe above it

Power from the Heat of Arctic Waters*

Energy Outrivaling That of the Niagaras May Be Recovered in the Far North. Will the Frozen Wastes Become an Unlimited Source of Wealth?

By **DR. H. BARJOT, H.M.R.**, University of Bordeaux.†

POWER is synonymous with progress and civilization. History proves this assertion. The white man leads the world today because, through invention and the possession of a scientific mind, he has been able to harness coal, water power, and other sources of energy, and thus to adapt the forces of Nature to his own ends. Other races, unable to do the same thing, remain in a backward social condition.

Slavery was due to the lack of power. The Roman mill could be kept turning only by a human motor—by a slave who might even be blinded in order to increase the efficiency of that engine. The same cause, the lack of power, will account for the social inequality of the Middle Ages; only a comparatively small privileged class could live on the luxuries provided by the labors of all the common herd.

The invention of the steam engine, more than any other factor, has changed this situation, liberating man through the products of the machinery it drives, and enabling more people to devote time to intellectual and spiritual pursuits. The discovery of a new source of energy, more than any other fact or social theory, brings about human progress.

In the final analysis, power, whether it be provided by animals or engines, has its origin in the sun's heat. But heat can not be turned into power at will. True, the greatest law of thermodynamics, Carnot's Law, tells us that power is generated by a thermal machine only by a drop in temperature from high to low, just as water turns a wheel only when falling from a high level to a lower one. In more common language, "cold," a relative degree of cold, is as necessary as warmth for getting mechanical energy from heat.

WE now obtain most of our power from coal and petroleum, because their combustion gives very large differences of temperature. But several centuries hence when our reckless consumption of coal has totally depleted our fuel reserves, and no more heat is available through combustion, we shall have only natural differences in temperature left to use. The hoped-for release of "intra-atomic" energy now appears to be quite impossible, or at least difficult. So the problem of finding new sources of power amounts to finding temperature differences in nature, no matter how small they may be, provided the respective hot and cold sources have large enough values to make up in quantity what they lack in quality. That possibilities of this kind are more important than was previously suspected has been demonstrated by the well-known scientist Georges Claude who recently showed that a 100-horsepower turbine could be kept running with a temperature difference of only 18 degrees Fahrenheit, at Ougrée in Belgium. Thus this project has already entered on practical possibilities.

Such natural sources are rather rare but such a source, outstanding in total magnitude, exists throughout the year both in the arctic and the antarctic; it also occurs in sub-arctic regions in winter time. These immense sources of energy are the basis of our power process. This process has already been outlined before the French Academy of Sciences.

We think of the arctic primarily as cold, but this is only because we customarily deal there with the atmosphere, its temperature being very low—about 40 degrees below zero. But by comparison with the atmosphere the big bodies of water in the arctic—the sea, rivers, and lakes—under the ice remain always unfrozen and their temperature is therefore above 32 degrees. This, when compared with the arctic atmosphere, is warm. The anomaly is due to one of the physical properties of ice—it is a splendid insulator of heat. Thus it prevents the leakage of heat from the water beneath it to the much colder atmosphere; provided, of course, it is thick enough. One recalls the "igloo" of the Eskimo where, under cover of ice walls, comfortable refuge can be taken from the most intense cold.

The heat thus retained in unfrozen water is enormous; it corresponds, in fact, to the latent heat of solidification, and thus one cubic meter of water when freezing can liberate the same amount of heat as the combustion of two gallons of petroleum. Such a form of heat can be utilized in the arctic because the atmosphere is cold enough and because this cold makes available an immense amount of potential energy which can be utilized to generate power. It has been proved, in fact, that with a thermodynamic efficiency of only 4 percent—although theory allows double that amount for an atmospheric temperature of five degrees below the Fahrenheit zero—a volume of water obtained from beneath the ice pack can produce the same amount of mechanical power as an equal volume of water falling from more than 4000 feet. There is no Niagara which is as powerful as this one, and it is available in the arctic on the shore of any river or any lake. Since the energy can also be generated from sea water, power in this form appears to be as unlimited as the oceans.

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* See editorial on page 189

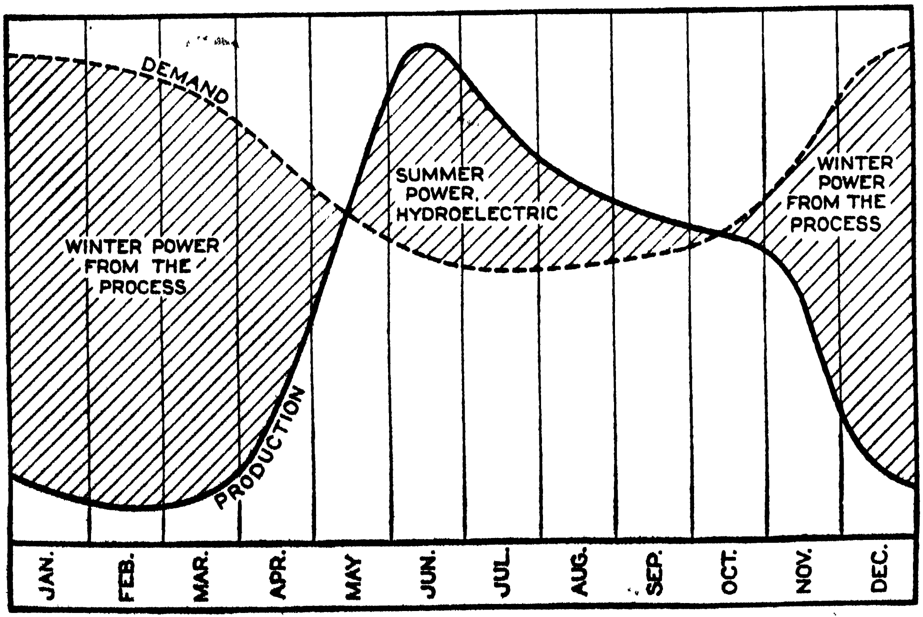
† See "Among Our Contributors," page 181

THE invention which we have had in mind during years, like all inventions, has required much developmental work. It has now reached the stage where it is suitable for practical application, through a simple and economical process. The apparatus will employ cold brine as a condenser, taking advantage of a well known property of a solution; namely, that when common salt is added to water the freezing point is considarably lowered, and the salted ice thus obtained—the so-called cryohydrate or "cryh"—is an effective refrigerating agent because its melting point is five degrees below the Fahrenheit zero. This substance, cryohydrate, is easily obtained in the arctic, simply by causing brine to freeze solid under normal weather conditions. It might therefore be said that the brine serves to collect the "cold" and concentrate it in tangible form.

Thus we would have the two differences in temperature required to generate power: First, the warm source, consisting of ordinary water, which freezes at 32 degrees. Second, the cold source, consisting of cryh which melts at a temperature of five degrees below zero. This standardized difference of temperature would bring about a flow of heat between the two sources, and a temperature difference is the fundamental and essential basis of a power plant.

A plant will preferably be installed on the shore of a lake or river, or by the sea. Unfrozen water, 1, (see diagram), pumped up through the ice pack will be directed into a boiler, 2, in same diagram. Here it will be mixed with a volatile liquid, 3. This volatile liquid, having low boiling point, will be caused to boil because it takes up the heat in the water. The volatile substance thus to be vaporized is one of the "light ends" produced in refining petroleum. These hydrocarbons of low boiling point possess the great advantage of being wholly insoluble in water, thus they can be mixed directly with it. This simple device provides an instant transfer of heat and permits the use of a simple and economical boiler. Normal butane, which boils at 30 degrees Fahrenheit under a pressure of 25 inches of mercury, would be particularly suitable for such a purpose. Because it would be condensed and used over and over again its cost would not be a large factor, especially since this petroleum by-product is very cheap, being wasted at present for lack of a market.

The butane vapor, 4, obtained as described, passes through standard low-pressure turbines, 5, and is exhausted, 6, into a condenser, 7. The condenser contains salt water ice ("cryh," 8) whose temperature is always below zero. The arriving vapor, 9, comes in contact with this sub-zero ice and is rapidly condensed or liquefied at low pressure (about 10 inches of mercury), meanwhile melting the ice.



WINTER POWER WOULD COMPLEMENT EXISTING SUMMER POWER

In the north, stream-flow in winter shrinks to a very low minimum. Hydro-electric plants are based on that minimum rather than a maximum. Winter power would compensate this

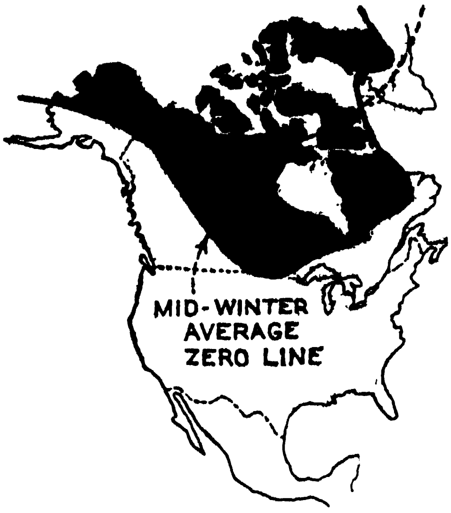
The condensed butane, 10, and the melted brine, 11, collect at the bottom and since these two do not mix they are easily separated on a basis of their differing density. Both are used over and over again; the butane is sent back to the boiler, and the brine is caused to resolidify or freeze, 12, by action of the extreme cold of the arctic atmosphere.

If we look at the matter broadly we see that the production of power by a transfer of heat energy from unfrozen water to a chill atmosphere is theoretically unlimited, but that in practice it depends upon the capacity of the transfer agent employed. The price of that material is consequently the crucial matter, and this is why the use of cheap brine is extremely advantageous. Common salt is a very cheap material, but here is does not even have to be purchased, for a brine can easily be produced in the arctic from sea water. For example, this would be the case were a plant to be built near the shore of Hudson Bay. Repeated freezings acting on an isolated quantity of sea water will, as is well known to arctic explorers, concentrate it as efficiently as evaporation. Pure water freezes first and automatically separates from the remaining liquid, and a concentrated brine is finally yielded. This operation would be carried on automatically in the boiler of the plant if it were fed with sea water. Here the large amounts of brine needed would be obtained as a by-product.

THE manufacture of cryh from brine is equally a simple operation, requiring no very special plant. Since the plant is working on the shore of a lake, for example, the natural ice sheet on that lake offers a ready-made smooth surface of large area over which the brine is poured. This liquid will spread over an immense area, will thus be brought into contact with the cold atmosphere, and will freeze rapidly. Mechanical scrapers moving on tracks will automatically clear up the brine and regularly supply the plant with cryh.

The capacity of the plant depends only upon the area of the cold surface just described; the use of brine as a medium permits the employment of an immense surface at low cost. A system of tubes to accomplish the same purpose would prove to be highly expensive; it has been proved by actual test that a simple tank having a volume of only 400 cubic feet, filled with cryh, would be equivalent to 300,000 lineal feet of one-inch tubing. Furthermore the use of an open-air ice sheet would provide a better condensing process because there would be no added surfaces to delay the exchange of temperature.

Another great advantage of this cryh condensing process is the ease of obtaining a storage plant. The production of power is practical and economical only when that production is regular, and particularly when the peak load is being supplied. In our process an accumulation of cryh is equivalent to an accumulation of power. Let us suppose, for example, that a lake of brine having an area of one square mile is frozen to a depth of six inches; such an amount of cryh will enable a 75,000-horsepower plant to run during 24 hours at a 100-percent load factor. Thus the cryh, more easily produced in large amounts during the coldest spells and particularly at night time, has only to be stored up against the peak load and the occasional warm days that occur in the arctic, even in mid-winter. The storage would require no very special construction—nothing like the expensive dams of a hydro-electric storage plant.



THE NEW NORTH

The black region is suitable for the Barjot power plan. It has many lakes and streams

In general, plants which utilize the process described will be very economical, having no elaborate costly construction comparable to the big dams required where the energy in falling water is recovered. The "boiler" and "condenser" are simply rooms in a concrete building; the turbines are standard low-pressure turbines; pumping unfrozen water from beneath the ice presents no difficulties; the brine is cheap and can be produced at the site for many plants. The capital investment will be low; an estimate for a large plant gave less than 35 dollars per horsepower installed, while hydro-electric plants involve a cost of about 200 dollars per horsepower.

The practical advantages will be obvious if we draw a comparison with the Claude process of harnessing the temperature variations of the oceans. The expensive pipe 3000 feet in length there required for obtaining cold water from the depths of the sea is not required in the type of plant at present under discussion. Here water has merely to be pumped up through an ice pack ten feet in maximum thickness. Furthermore this process makes use of the latent heat of freezing which, for the same mass of water, is 80 times as great as the specific heat used in the other process.

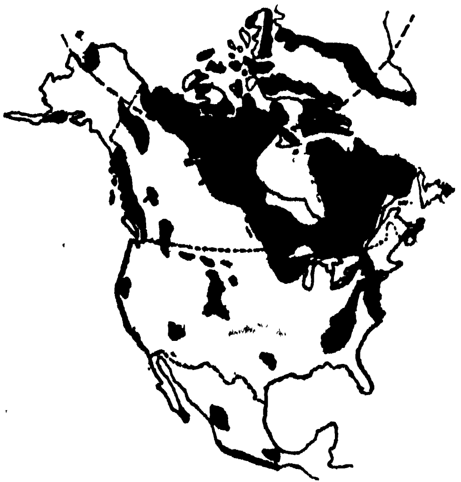
The region in Canada extending from Labrador to Alaska, all along the arctic coast and around Hudson Bay, is known as "the richest repository of base and precious metal in the world." The "pre-Cambrian Shield" or "Canadian Shield," more than 2,000,000 square miles in area, contains a wide range of minerals. Its southern extension in the United States, less than 5 percent of the total, has provided the Lake Superior iron mines and the Michigan copper mines which have played so large a part in America's pre-eminence in the mining industry. The largest part of the minerals of the Canadian Shield lie in the Great North, in that great region long regarded as a frozen waste. Among the potentialities of greatest known importance are the enormous deposits of native copper in the Coppermine River basin, situated under the Arctic Circle and recently estimated as a billion tons, and that fabulous reserve of iron ore at the recently discovered Belcher Islands in Hudson Bay.

An extreme degree of cold and the lack of power have thus far prevented the exploitation of this wealth. A hard winter lasting about nine months freezes the streams, which can not therefore be harnessed hydro-electrically to advantage. These lands may now be regarded in a new light—as the lands of power. Fiords, rivers, and lakes are innumerable in that region and the process can therefore be carried out virtually anywhere. The present trend of settlement northward will be accelerated and a new part of the world opened to exploitation. Cheap metals should become available, due to a great industry wholly contingent on the vast new source of energy.

The process would be applicable not merely to the far northern fringe of Canada but to areas much to the south of this. It is well known that the great hydro-electric plants of central Canada are seriously hampered by the severe winters, and that most of them are reduced to a low capacity. The Saskatchewan Power Commission recently decided on the impossibility of making profitable use of the existing power, because in this province "the variation in the flow of the river is as much as 100 times greater in summer when the demand is light than in winter when the demand is heavy, the variation being all the way between the maximum flow of 188,546 cubic feet per second to a minimum of only 850 cubic feet per second." (reports Sask. Power Com., *Power Age*, January, 1929). This is due to the fact that water is immobilized in solid form in winter.

Unfortunately this shrinkage occurs during the very season of the greatest demand and requires the provision of steam stand-by plants. It is, however, illogical to burn coal when so much heat is already contained in any nearby lake or river. Again let us remember that unfrozen water can give more power in freezing than if falling through a head of 4000 feet. This "winter white coal" is largely available in central Canada because of its intense cold, and therefore the winter power plants utilizing the process at times of peak will fit admirably into the existing seasonal "valley," supplementing the hydro-electric installations.

The energy obtained during the cold months would be so abundant and cheap that it could even be used economically for electric heating purposes. What a curious paradox: the colder the winter the more efficient the process and the more heat! King Zero will be forced to destroy himself. The present handicap to the settlement of the arctic will be removed. The American continent, granted by the accidents of Nature a Far North which it now turns out is really a land of power, will become a center of civilization.



THE CANADIAN SHIELD

This area of pre-Cambrian rocks is a rich source of metals, but much power is needed

Finally, mankind has now the safe assurance that there is in the polar regions a source of power which will never be depleted; and which, incidentally, it will no doubt become steadily easier to transmit to greater and greater distances because the distance to which electrical energy can be transmitted is increasing every day.

High-Speed Tickers to Serve Brokers

MUCH of the chaos—and many of the losses—incident to the recent stock crash was due to the tardiness of the stock ticker, the type used having been in service for 10 to 15 years. Trading off "the floor" was largely guess-work for brokers dependent upon the tickers, because by the time quotations reached them, many wild fluctuations had taken place.

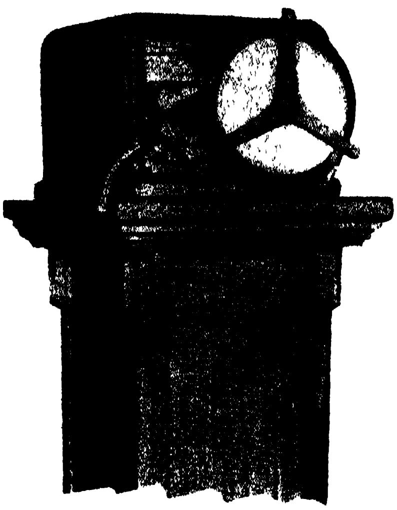
The recent announcement by the Western Union Telegraph Company that they are beginning installation of new high-speed stock tickers throughout the country will, to a large extent, prevent a recurrence of this situation in the future. Design and development of this high-speed ticker occupied practically three years' time and was a result of the combined efforts of ticker and printing telegraph engineers of the Western Union, the New York Stock Exchange, and the Teletype Corporation of Chicago.

WHILE this new ticker is a cumulative result of developments and improvements rather than any startling new invention, it is based upon principles which enable it to operate at practically twice the speed of the old tickers. It requires only one main line wire instead of two as formerly used.

With the old style ticker a considerable amount of power must be supplied over the telegraph signal wires and a considerable time is required to rotate the typewheel from one printing position to another, since the alternating current impulses which control this rotation cannot be sent at a speed greater than ordinary automatic signaling speed. The new high-speed ticker development, therefore, took place along the lines of reducing the operation to one-wire control, reducing the amount of signaling current required, furnishing a local source of power at the ticker, and a change of code which would not require so many transmitted impulses to control the position of the typewheel.

The new ticker operates on a start-stop principle similar to the well-known Simplex printers which are coming into general use as a part of telegraph equipment. A local source of power is supplied by having a small electric motor which furnishes the driving means for rotating all the moving elements in the ticker and performing the operations of shifting, printing, rotating the typewheel, et cetera.

Instead of the step-by-step code which averaged 16 current units for each character printed, a permutation code is used which, with start and stop impulses added for each character, makes a total of eight current unit impulses for each character. There is only one magnet in the new ticker whereas there are four in the old. One important feature in the design is the fact that one character is really "stored" in the ticker mechanism and is being printed while the selection impulses for the next following character are being received and stored.



NO LONGER A DOME

The old familiar dome of the stock ticker is going out of style. This is the new one

TICKER CIRCUIT BOARD

A section of the ticker circuit board controlling ticker circuits serving New York

The 4,500,000-dollar program involving nationwide installation of the high speed stock tickers required construction of 5000 miles of new city-to-city wires, mapping of numerous curcuit changes and wire installations in 350 cities all over the country and in parts of Canada, and an enormous amount of other preparatory work. To prevent discrimination, the new tickers will be operated at the same speed as the old ones until all the old tickers in the country have been replaced. Some 3000 new tickers will be installed on Western Union circuits in New York City, in about four months. At least six months more will be necessary to rush work to completion in the balance of the country.

QUOTATIONS BY WIRE

An operator sending quotations from the new high-speed ticker sending station of Western Union at 40 Broad Street, New York

SERVING THE COUNTRY'S BROKERS

General view of the sending apparatus. In background a man watches a distributor receive impulses from the operating table

THE FIRST "MOVING PICTURES," REPRODUCED FROM THE ORIGINAL

"Animal Locomotion" is the title of the large volume in the possession of the editor, from which this page was reproduced. The same work is described on the fly leaf as "An Electro-photographic Investigation of Consecutive Phases of Animal Locomotion, 1872-1885, by Eadweard Muybridge, Published under the Auspices of the University of Pennsylvania," in 1887. See the text of the article

Our Eyes and the Movies

How the Laboratory Psychologist Explains by Means of Physiological Optics Some of the Phenomena of Moving Pictures

By DONALD A. LAIRD, Ph.D., Sci.D.
Director, Colgate Psychological Laboratory

An argument that could not be answered, and a rich man's natural inquisitiveness marked the birth of the movies. Now one out of five in the United States is a movie addict, according to compilations made by the industry, public schools are using movies for educational purposes, salesman are using them to supplement their sales talks, and when Walter Gifford, president of the American Telephone and Telegraph Company, cannot be at a banquet to make a speech in person, he makes a "talkie" of himself appropriate for the occasion and is represented in proxy by an operator of a projecting machine.

All this resulted from the bet of a wealthy sportsman and philanthropist 50 years ago, and on the application of some dry-as-dust discoveries and laws scientists unearthed nearly a century ago. Out of these origins has come the celluloid ribbon which claims 25,000,000 of us as well-nigh incurable movie addicts and touches closely the lives of as many more.

Science has accomplished so much that concerns moving pictures in the last century that we have developed a nonchalant, matter-of-fact attitude toward these achievements. We are content simply to enjoy the beauty or amusement rather than trying inquisitively to find out "what makes it go."

While hundreds of men who labored through two centuries have made essential contributions to the development of the motion picture, it is generally recognized that the first actual pictures were taken at Palo Alto, California, on the stock farm of Leland Stanford, in 1878 and 1879. Stanford turned his vast resources and ingenuity to settling some arguments on which wagers had been laid about how horses ran.

Eadweard J. Muybridge, sometimes known as Edward James Muggeridge, and John D. Isaacs, worked with Mr. Stanford in arranging a battery of 24 cameras so that a moving object, such as a racehorse or a human being walking, would expose each plate in serial order and would leave behind a photographic record of each of 24 closely timed phases of his movements.

While the investigation was planned primarily to settle arguments about racehorses, the developed negatives upset many conventional ideas about pole vaulting, sprinting, and even pleasure walking; the human brain and eye, apparently, had not in the past really analyzed motion itself but had reacted to a composite, and at best a rather hazy, picture. From this crude start, experimental work continued.

When we see, the light which enters the eye produces the sensations of vision by changing the chemical constitution of the sensitive retinal coating of the inner surface of the eyeball. The chemical changes do not cease immediately when the light is cut off. Everyone has seen the after-effects of this persistent chemical reaction when looking at the light in his bedroom just before turning it off for the night. The light is extinguished, but a weak image of it persists in the eye and remains, no matter what direction the eye turns. The same after-image is seen when riding at night and looking directly into the headlights of an approaching automobile; after the automobile has passed, the persistent image which is caused by the lag of the chemical reaction is seen dancing around like a firefly.

When a very strong light is used, these after-images last longest. So in experiments to reduce the flicker in movies it was found that, by substituting an arc light for the old carbon-filament bulb, the pictures could be made bright enough so that the chemical change of the first picture persisted in the eye while the cut-off blade of the shutter was hiding the second picture which was being jerked into place. But that was not all. Flicker still persisted and movies in the early professional exhibition hall flickered much as the blades of an electric fan do as they are coming to a stop. Of course it was not the blades or the pictures on the screen that flickered, but the overlapping chemical changes in the retina of the eye.

Ordinary visual impressions last in

the retina for about three thousandths of a second after they are cut off. The stronger impressions from a bright movie screen will last longer, but not enough to eliminate flicker. So "Talbot's Law" was called upon. This is a law from pure science but it solved the critical problem of movie projection.

Talbot's Law states that in rotating a disk made up of sectors of black and white, flicker decreases as the speed of rotation increases, with the intensity of illumination, and with the number of interruptions. The speed of films could not be increased practically and economically and the intensity of lighting of the pictures had been increased as far as seemed possible. So why not interrupt the light more? That is what they did. One shutter had to be used to hide the motion of the new picture being hauled into place, so another, and usually smaller, blade was added. Its function was to pass its shadow across the screen while the picture was being shown. Adding this second shadow diminished the flicker. Instead of interrupting the light on the screen just once for each picture, a second and sometimes a third interruption is now added. Paradoxical as it may seem, flicker disappears. Doubling or tripling the number of times the light is broken lessens the brightness of the picture seen by the eye, as predicted by Talbot's Law, but substitutes steady fusion of after-images and does away with flicker. Only when the machine is running too slowly or when the light is momentarily weakened does flicker appear.

IN the home projection of movies flicker may appear, due to several causes. If the home projector is moved a distance from the screen so that the size of the picture is increased, the intensity of illumination of the screen is decreased and may be reduced to a point where the after-images are too weak to carry over the darkened intervals on the screen. The motor may also be running slowly, due to lack of oiling. If the room is not darkened flicker will be difficult to avoid because the after-images fuse most readily when the general illumination is least.

While the home projector should be placed as close to the screen as possible in order to obtain the brightest picture that is consistent with adequate size, the spectators should sit as far from the screen as possible. When the spectators sit at a considerable distance from the screen the image of the picture is focused on the central region of the retina, but if they sit close to the screen the corners of the picture are focused on the peripheral or marginal portions of the retina. This marginal retina is especially sensitive to flicker. Thus, by sitting close to the screen one sees the central part of the picture fusing perfectly but the corners of the picture present an annoying amount of flicker.

When a common cotton screen is used the spectators should sit directly in front of the screen, because it reflects the maximum light directly backward. In moving picture theaters mirror or ribbed screens are used which reflect the rays to the spectators at the sides of the stage. Most screens used for home projection do not do this.

There are always a few persons whose eyes are irritated by the movies. This is due to individual peculiarities in the critical flicker threshold, and is not a defect of movie projection but a human idiosyncracy.

The fusion replaces flicker quickest when the predominating color is bluish, but the light of the carbon arc or incandescent bulb used in projecting the pictures has an excess of red and yellow rays and a deficiency of blue rays. In some professional machines lenses are used having a bluish cast. These filter out the excess of red and yellow and consequently give a smoother picture with the best fusion in the intermittent images. Some of the patented ribbed and mirror screens are so constructed that reds and yellows are absorbed to some extent, thus giving the screen and the picture it reflects a slight bluish cast. In home projection it will help if the cotton screen is thoroughly blued by the laundress. In the more skillfully designed moving picture theaters the lights that are kept on in the auditorium during the projection of a picture have bluish reflectors or filters in order to give this color help to fusion.

Do movies harm the eyes? Many people think so. A few years ago a responsible public health official made this prediction: "Motion pictures will be extinct in ten years. The public realization that they are ruining eyesight will lead to a demand that they be abolished. Within ten years I predict that there will be no more motion picture shows in America. By that time they will be barred as a pernicious evil to health."

Some people undoubtedly do experience eye strain at the movies, but this is usually the result of their eyes having defects which they have not discovered and had corrected. Or they may habitually sit too close to the screen or too far to one side. As a matter of fact actual measurements have shown that viewing a movie projected with ordinary care is less fatiguing to the eyes than ordinary reading for the same length of time. Theoretically the movies should be fatiguing, but practically they are not. There is one type of scene, however, which may readily be very fatiguing to the eyes. This is where counter-motion is shown, as in a parade where trained marchers are in military formation and the jerky movements of their legs are in the immediate foreground. This produces jerky and irritating sensations.

MOVIES seem to be peculiarly a human institution, animals indicating little, if any, interest in them. Not only household pets but primates which have been experimented upon show no interest in movies and are more likely to look away from the screen than at the screen. This is likely due to the eyes of animals not having the photochemical changes that make it possible to fuse the pictures. Dogs are interested in their own images in mirrors and in lithographic sheets portraying other dogs, but they do not look at dogs in movies. Probably this is because the movie screen looks to them as the slowly whirling blades of an electric fan look to us. It has been experimentally demonstrated that some animals, such as the parrot, do have after-images, but it would appear that their after-images do not follow the same time course that ours do.

THE EQUIPMENT USED BY EADWEARD MUYBRIDGE

From the SCIENTIFIC AMERICAN Supplement, February 5, 1887. "On the left," reads the legend, "is the reflecting screen against which the animal appeared *en silhouette*. On the right is the series of photographic apparatus of which each one took an image of the animal"

The Romance of Steel

Most of Us Take the Metal Iron Too Often for Granted. Were Iron Newly Discovered, Its Unusual Qualities Would Cause It to be Regarded as a Remarkable Element

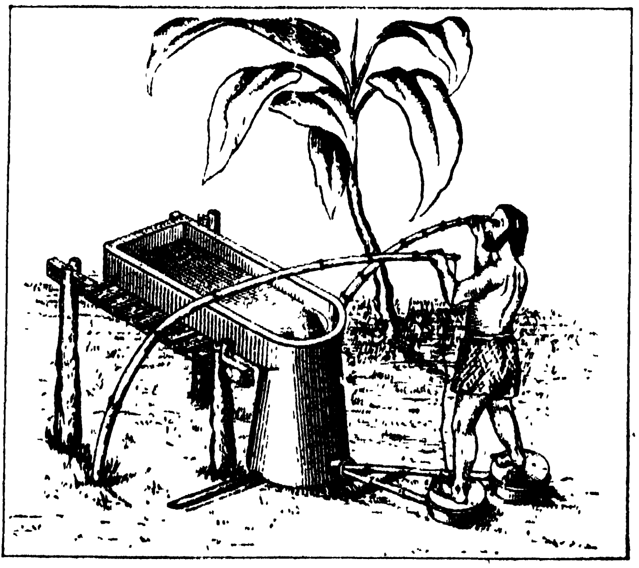
By MARTIN MEYER, Ph.D.
Assistant Professor of Chemistry, College of the City of New York

MANY thousands of years ago men were savage aborigines roaming about clothed in the skins of animals than which they were little better. Their chief cause of concern and object in life was to secure food enough to prolong their miserable existence. Surrounded by beasts of a ferocity unknown in modern times, their only weapons were crudely fabricated from wood, stone, bone, and later bronze and the softer metals. Then one day one of their comrades discovered that a rusty earth could be treated with fire to produce a material, iron, which could be fashioned into implements of an efficiency immeasurably greater than those of the time. It was one of the most important discoveries that the human race has ever made, ranking second only to the discovery of fire itself; so important, in fact, that the subsequent period is known as the Iron Age.

THE Iron Age endured from this dim dawn of humanity down to only 80 years ago, when mankind entered another epoch which might quite as rightfully be designated the Age of Steel. The date is fixed by the discovery of the Bessemer process for the manufacture of steel in 1855, and the importance by the events that have since transpired. As great an improvement over wood and stone as is iron, just so much greater is steel over all other metals.

The manufacture of steel is based upon the fact that iron possesses the peculiar and almost unique property of dissolving the element carbon, and thereby acquires some startling new properties which are further enhanced by the addition of other materials. While this was known long before 1855 and the perfection of Bessemer's process, it was not until then that steel began to be produced in the quantities that it is today.

The metals form an interesting group of elements. They are all relatively hard, strong, heavy materials, usually (except copper and gold) of a silvery appearance, and have what is commonly called a "metallic luster." They have an infinite number of uses, many of which are familiar to everyone. Copper is used for electric wires because of the cheaper metals it is the best electrical conductor, nickel for plating because it takes a high polish, aluminum for airships because it is light and strong—each metal has uses which depend upon its properties. This is what makes steel the valuable material that it is. Cheapest of all metals, composed mainly of iron to an extent always greater than 90 percent by weight, it is nevertheless not one metal, but many, because the nature and the amount of the other 10 percent makes an infinite difference in the material.



PRIMITIVE IRON SMELTING

The bellows are worked by the artisan's feet. The discovery of iron smelting was made in Africa by the negro

As steel, iron is the Proteus of the metals. Considering iron only from the standpoint of the carbon it contains, one finds at least three different and easily distinguishable varieties. When it has about 4 percent of carbon, which is about all it will hold, down to 2 percent it goes by the name of cast iron. This metal is hard, easily cast in molds since, like water, it expands on solidifying (a most unusual property) and takes a sharp impression of the mold. But it is quite brittle, so that it may be shattered easily, even by a blow from a hammer. Stoves are made of cast iron and one frequently breaks parts simply by dropping them.

When iron is given from 2 percent to 0.2 percent of carbon we have steel with somewhat contrasting properties. Not as hard as cast iron it is infinitely stronger, though normally it does not cast as well. Steel can be made with a tensile strength of more than 200,000 pounds per square inch; that is, so strong that a rope of only one such strand would suffice to lift a locomotive.

With less than 0.2 percent of carbon iron is called wrought iron, a material which is still softer than steel but quite tenacious and has many uses.

It is, however, the strength of steel which is proverbial and which makes the modern world the land of miracles that it is. Without steel there would be no railroads, no large bridges, no Woolworth and no Chrysler Building, and practically none of the wonderful machinery by which manufacturing operations are conducted.

THAT, however, would not be a great loss, for without steel there would not be nearly as much to manufacture, to say nothing of the countless smaller but equally indispensable things which are dependent upon this interesting material.

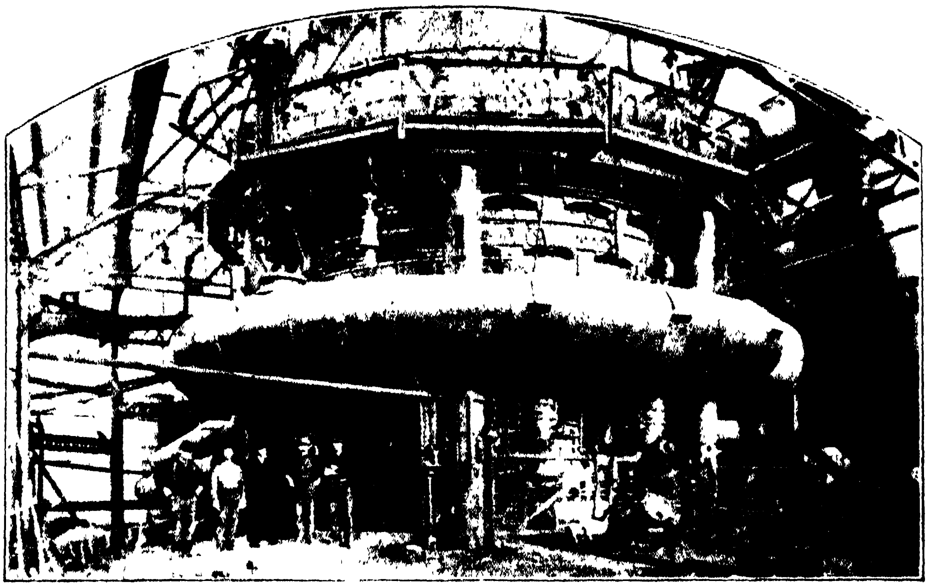
But the properties of steel may be still further and more widely modified by the addition of smaller amounts of other substances. Normally iron is magnetic but loses its magnetism slowly, and strongly resists attempts to change the polarity of its magnetization rapidly. After the addition of tungsten and small amounts of chromium it may be magnetized and will retain the magnetism practically forever, the so-called "permanent magnets," while on the other hand, if it contains silicon it may be magnetized in one direction, demagnetized, and magnetized in the opposite direction a hundred times a second with only a very slight loss, known as hysteresis or magnetic lag. Ordinarily steel rusts quite readily, but by the addition of silicon in large quantities one obtains Duriron which resists corrosion of even the strongest acids, while the addition of chromium yields the "stainless steels" which are used in cutlery.

For all these reasons and many more, our modern civilization is dependent upon steel, and to call this the Age of Steel is merely stating a fact.

From whence comes this interesting material? Like the other metals it is derived from ores or earthy materials found in the ground, of which there are extensive deposits in the United States on the shores of the Great Lakes and in other places, in Spain, Germany, France, Russia, and in other countries. A new deposit has been found at Koolan Island in the Yampi Sound, a little dot in the wastes of the Southern Pacific Ocean. It is said to consist of more than 100,000,000 tons of the highest grade ore, with more under the ocean bed, and this will doubtless influence the future of the British Empire. Large deposits have also only recently been discovered at Kursk in Russia.

The most desired ores of iron are three in number—limonite, haematite, and magnetite. The last is the most valuable but also the rarest of the three, for it contains when pure about 75 percent of iron. It is the "lodestone" of the ancients, of which one rock was said to be so highly magnetic that it drew the nails from passing ships and unfortunate sailors had to swim for their lives. Like the report of Mark Twain's death, this is doubtless considerably exaggerated, but magnetite is highly magnetic for a nonmetal, or even a metal other than iron itself.

THE ores are oxides, that is, compounds of iron and oxygen, and to obtain the iron one must remove the oxygen. The first operation in the manufacture of steel is smelting. This is conducted in a blast furnace and results in the production of cast iron. A blast furnace is a huge circular building about 100 feet high and 30 feet in diameter, having the general shape of two truncated cones placed base to base. Ore, coke, and limestone are charged into the top of the blast furnace, air is blown in to burn the coke, which removes the oxygen from the ore, and liquid iron at a temperature of 2200°, Fahrenheit, is tapped out of the furnace every few hours. If the ore were pure oxide of iron, only carbon would be necessary to remove the oxygen, but as would be expected of a material dug from the earth, it may also contain sand or limestone, although nearly always it does contain sand. This would clog up the furnace and make difficulty in the smelting operations. So lime is added as a flux, and it combines with the sand to form an easily melted slag that is also tapped off from the bottom of the furnace. This slag is very similar in appearance to a poor grade of glass, and when ground finds some application as an abrasive or cutting or polishing material.



THE BASE OF A MODERN BLAST FURNACE

Such a furnace is charged with ore, coke, and limestone (as flux) and is kept running continuously for years. Air under pressure enters from the large horizontal, circular tube

The design, operation, and improvements of blast furnaces form interesting stories in themselves. Today they are almost always entirely mechanical in operation. Years ago they had to be charged by hand. Men climbed to the top of the structure, opened the door of the fiery inferno to drop in the charge, then jumped back to avoid the rush of flame which always followed. Sometimes they did not jump quickly enough and paid for their lack of agility with their lives.

The iron from the blast furnace has been made in contact with coke which is almost pure carbon, and therefore contains about all the carbon it can hold, about 4 percent. It is "pig iron" and the problem of making steel is that of reducing this carbon content to the desired 2 percent or less. The oldest method of accomplishing this purpose is by the open hearth process, which consists simply in melting the pig iron in large shallow beds lined with iron ore. The oxygen in the ore combines with the carbon of the iron and we get more iron out of the furnace than we actually put in.

Pig iron, however, also contains all of the impurities which were present in the original coke and ore—usually silicon, manganese, phosphorus, and sulfur—and these, especially the last two, give a steel with undesirable properties as it is likely to be brittle either when hot or when cold. During the World War this became a very serious problem, for it was found that the amount of sulfur in the coke which was being made was increasing. Special precautions must be taken at this point to remove them, and the furnace is always lined with either a basic or an acid lining, depending upon the chemical nature of the impurities. The lining usually takes the form of a sand or limestone layer. This is slowly eaten away in successive operations and has to be replaced at intervals. Finally the furnace is tapped and the liquid steel runs in thick fiery streams into ladles where alloying materials are added if special steels are required. More than 17 other metals are added to steel to confer upon it different properties for particular purposes.

From the ladles the steel may be cast into ingots which, in turn, go to the rolling mills to be rolled, hammered, cut, slotted, and shaped into rails, sheets, beams, and an almost infinite number of other things. By perfect marvels of mechanical ingenuity this tough and hard material is handled as easily as one may fashion butter.

ABOUT 1854 it occurred to Henry Bessemer that, since the problem of making steel from cast iron was simply one of removing carbon, this could be done most simply by burning it out with the oxygen of the air. He built a large egg-shaped machine into which he placed molten pig iron and proceeded to blow air through it. The idea worked so well that it failed. As the carbon is removed from the iron its melting point rises. In this case the air removed the carbon so rapidly that the temperature could not keep the iron liquid. It solidified and ruined the expensive machine. But eventually Bessemer solved the problem by blowing the air upon the iron instead of through it.

The idea was really conceived by Kelly, while Mushet and others improved it, but chiefly it was Bessemer who made it practicable. It was certainly he who received the rewards, for probably no great invention was so quickly and largely rewarded. It is estimated that before his death in 1898 Bessemer had received upwards of 5,000,000 dollars as the proceeds of this one discovery. Although he made other inventions in his life, none was of any importance in comparison with this.

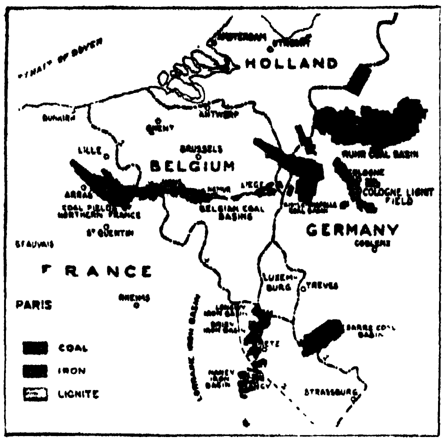
The idea eventually revolutionized the steel industry. At first it resulted in the production of steel at a price with which no other method could compete. Now when the price differential has been largely overcome, it still holds this advantage: large Bessemer "converters," as they are called, hold only 25 tons of steel, while an open hearth furnace may hold 200, but the latter takes eight hours for one run while a "converter" turns out its charge every 15 minutes. It furnishes a better feed for a rolling mill for it is cheaper to handle a steady small stream of material than a large quantity at infrequent intervals. In a large modern mill the ore is never allowed to cool down from the time it enters the blast furnace until it comes out as the product.

A DESCRIPTION of each step in the process reads like an ovel, and no one who has had the privilege of visiting a steel plant will ever forget the experience. The magnitude of the operations, the temperature of the furnaces and the molten metal, the noise of the mills, and the bare-shouldered workmen, like gnomes, controlling the work, combine to form a spectacle as impressive in its way as a Niagara or a Mammoth Cave. For many purposes, steel is manufactured in other ways, by the Duplex and Triplex processes, in crucible furnaces, and day by day more is being made by electricity.

Since Bessemer's invention the industry has grown by leaps and bounds until it is the most important in the world. Today it controls even matters of a political nature, for the principal problem in Europe's political tangle is no longer to maintain a "balance of power" but to maintain that which today is, from a national standpoint, infinitely more important, a "balance of steel." The world's production has risen from only a few thousand tons in Bessemer's day to over 76,000,000 in 1913 and around 100,000,000 today, valued at current market prices at about 36 dollars per ton.

From the figures of cast iron and steel production and cost, students of business foresee the course of commerce and stock speculators forecast the trend of the market. Quite remarkable correlations have been shown between carefully prepared analyses and actual subsequent facts.

It is more than an interesting comment on the effect of modern science on modern life to trace the influence of steel production upon the course of current history. The greatest body of iron ore in Europe was shared prior to the war by France, Germany, and Luxemburg, and before the war Germany produced more steel than did the other three great steel producing nations of the old world, England, France, and Belgium combined, while the United States produced about the same total quantity, around 40 percent of the world's annual supply.



IRON MEANS POWER

The iron ores between the present boundary (1) and the old one (2) have passed from German hands to the French

In the modern world steel production is the keystone to all else; steel means power and commercial preeminence. To it Germany owed her commercial supremacy and to her commercial supremacy she owed the war. By the Versailles Treaty France hoped to destroy that supremacy forever, for she thereby got Lorraine and the main portion of Germany's western ore deposits. But that has not solved the problem nor won the economic battle for France, even though she has won the war, for she did not win the coal.

In the natural course of economic events ore must go to coal to be smelted and not the reverse, as we see in our own country. Our great deposits of iron ore are on the banks of the Great Lakes but the center of the steel industry is with the coal in Pennsylvania. Coal is light and bulky, and expensive to ship, while ore is heavy and compact. France did not get the Ruhr coal deposits, and only a small part of the Sarre, although she has made heroic efforts to maintain control of them, so the actual ownership of the ore means little. Realizing the economics of the situation it is doubtful whether England could be brought to look with any degree of sympathy upon French desires for these coal deposits regardless of the other issues which might be raised to enhance the French ambition, and this is the problem which will remain for solution for some time to come. The recent formation of the European steel *cartel* or trust will write a new chapter and perhaps a whole volume in this story. In the meantime our own production has been mounting. Since 1916 we have produced more than 50 percent of the supply of the entire world. For us from that standpoint the future seems secure.

What Is Your Opinion?

This article is one of a series. All are elementary and deal largely with the romance of chemistry. Whether several more articles of this series will be published or not will depend entirely on the number of votes received from individual readers. A post card will suffice. —The Editor.

A BESSEMER CONVERTER IN ACTION

To make steel from iron, some of the carbon is burned out, either in the Bessemer converter or by the "open hearth" process. Today about three fourths of the steel is made by the latter process yielding a better product, and one fourth is made by the Bessemer process

An Experiment in Suspended Gravitation

We May Reason Out One Kind of an Answer to a Question in Physics and Arrive at an Opposite Answer By Actual Experiment. Experiment Wins

By R. W. WOOD, LL.D.
Professor of Experimental Physics at Johns Hopkins University
Corresponding Editor, SCIENTIFIC AMERICAN

IF a bottle of water is allowed to fall, and a large air bubble is released at the moment at which the bottle is dropped, will the bubble rise in the water?

Having received an incorrect answer in a surprisingly large number of cases, it seemed of interest to devise an experiment which would demonstrate the abolition of hydrostatic pressure in falling water, and the consequent disappearance of buoyancy.

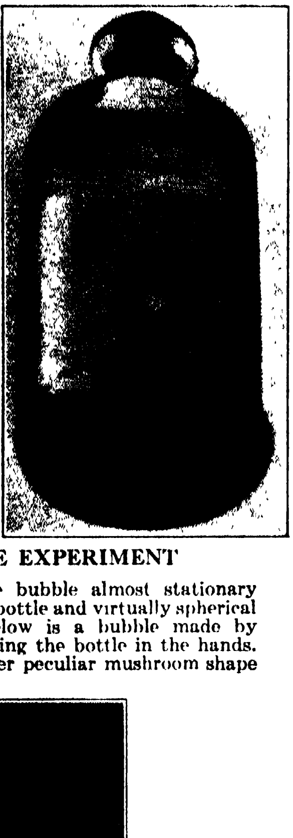
Everyone is familiar with the circumstance that in an elevator a suitcase held in the hand feels much lighter at the moment at which the cage commences to descend, and much heavier at the moment at which the descent is being arrested. If the supporting cable breaks and the car falls freely the suitcase weighs nothing at all and feels as light as a feather—although this observation has not been put on record, so far as I know, by the victim of any elevator accident. The experiment can be tried on a smaller scale by jumping from a height of five or six feet.

THIS suspension of gravitation occurs also within the interior of bodies shot up into the air, and the error made by Jules Verne in his "Trip to the Moon," in having gravitation disappear within the projectile *only* at the moment when it passed the center of gravity of the earth-moon system, has surprised many of his readers.

From these considerations it is clear that the hydrostatic pressure of water, which obviously depends upon its weight, disappears also when the mass of water is rising or falling freely in the air (neglecting a small effect due to air resistance, which prevents a "free fall").

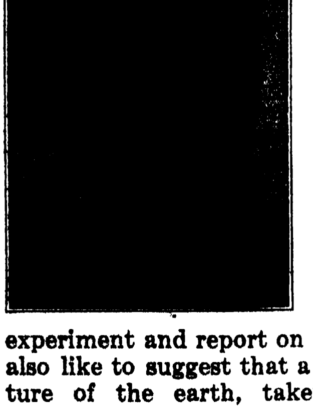
A parachute jumper could try some amusing experiments with a corked bottle of water containing a small quantity of air. If at the moment of jumping he inverted the bottle, the air bubble would remain for a few seconds at the bottom, and then rise slowly as the air resistance reduced his acceleration. As soon as he reached his final "terminal velocity," which is something like 120 miles an hour for the human body in a horizontal position and in air, there would be no further acceleration, and his velocity would remain constant until he opened his parachute. During the time of fall at constant velocity the air bubble would rise with its customary velocity.

Possibly some of our air service men who think nothing of dropping a thousand feet or so before opening their parachutes may be willing to try the experiment and report on it. I should also like to suggest that a moving picture of the earth, taken with the machine pointing straight down, during a free fall of several thousand feet, would be of considerable interest. It could easily be done with one of the lighter cameras operated by a spring drive, or perhaps even with a standard machine, although the latter might give more trouble later, in making the landing.



THE EXPERIMENT

Above is the bubble almost stationary in the falling bottle and virtually spherical in form. Below is a bubble made by simply inverting the bottle in the hands. Note its rather peculiar mushroom shape



The stationary bubble in the bottle can be observed, however, in a far less hazardous manner. After giving some thought to the problem of how to drop a bottle and release an air bubble at the bottom at the same moment, it occurred to me to toss the bottle into the air. After some little practice I learned how to do this in such a way as to bring the bubble to the center of the bottle at the moment at which it could most clearly be seen, namely, at the top of its flight when it is moving slowly.

If the bottle is properly thrown to a height of a foot or two above the head, we see the large silvery bubble poised at the center, almost spherical in form. If, however, we invert the bottle by a quick turn of the wrist, the bubble rises rapidly in a much flattened form having a mushroom shape. The two conditions are illustrated by photographs, taken with a shutter speed of 1-500 second with the sky as a background. The bottle was tossed up with one hand and the shutter sprung with the other.

THE best method of observing the suspended bubble is to stand facing the light, holding the bottle, cork down, loosely in the palm of the right hand at an angle of about 45 degrees, the arm hanging by the side. The bubble should be about the size of a peanut.

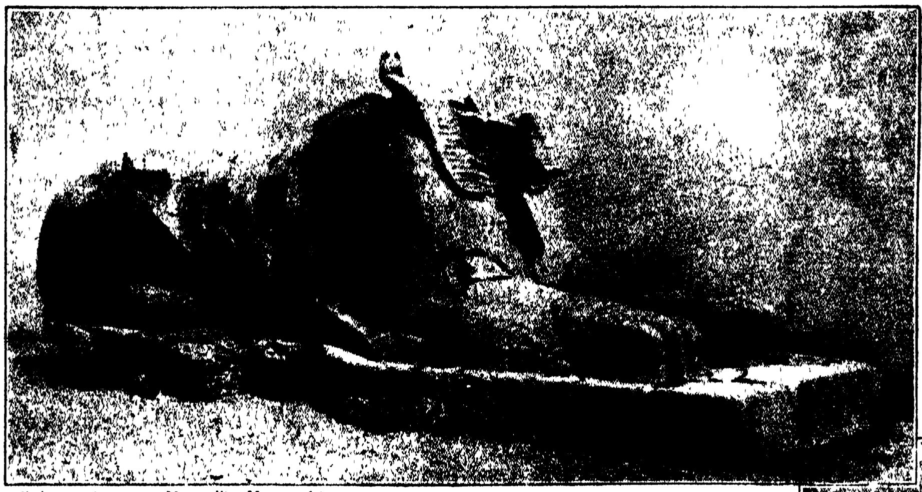
The bottle is now tossed up by a free upward swing of the arm, in such a way that it turns slowly and assumes an upright position at the top of its flight. The first attempt will probably result in a double somersault, but with a little practice the toss can be properly made. The best result is obtained by letting the bottle slide off the palm of its own accord, by straightening the fingers at the proper moment. If the bubble rises rather rapidly, as is sometimes the case, it is due to currents set up in the bottle by an incorrect release. However, a little actual practice will have more value than many words.

An Archeologist-Detective at Work

With Only a Vague Clue as a Starting Point, Queen Meryet-Amun's Tomb Was Unearthed

THE annual report of the Metropolitan Museum's excavations at Thebes is, as usual, written by Mr. Herbert E. Winlock, who has that rare ability of making archeology real and vibrant to the lay reader. It will be remembered that the stories of the expeditions in the last two years, presented in the SCIENTIFIC AMERICAN, have been very largely devoted to an account of the discovery of statues and sphinxes broken up and buried near Deir el Bahri. We have already related how Queen Hat-shepsut usurped the throne during the youth of King Thut-mose III and built a temple to justify her usurpation. When she died in 1479 B.C. the young king tried to expunge all memory of her by destroying inscriptions, statues, et cetera. Mr. Winlock says:

"To finish clearing away what still remained of Naville's debris [See SCIENTIFIC AMERICAN for June, 1929, page 522] and to expose the rest of the quarry was the task on which we spent the first part of the past season. Meantime, while the men were digging, we went back to the slow, laborious grind of sorting out and fitting together the fragments found during the previous years."



All photographs courtesy Metropolitan Museum of Art

THE SPHINX'S HEAD IS FOUND

The head was found in Berlin and the body was found in Egypt. They were pieced together; result, a perfect statue

Detective work by the expedition, on statues and sphinxes found at Deir el Bahri before the discovery of the tomb of Queen Meryet-Amun, brought other surprising results. The torso of one statue dug up by the expedition only a year or two ago at Deir el Bahri was found to fit a head taken by German Egyptologists to Berlin in 1843-45. The same situation existed in regard to a granite sphinx. The Metropolitan's expedition also discovered fragments of a statue of Queen Hat-shepsut, the torso of which was taken to Holland in 1869 by Prince Henry, High Admiral of the Netherlands Fleet. Negotiations are now afoot for the reuniting of these statues.

The next interesting feature which Mr. Winlock describes is the Osiride statue of Hat-shepsut referred to in our issue of June, 1929, page 524. Mr. Winlock continues:

"For another piece of architectural sculpture—this time of gigantic size—the problem of location was solved last season and the actual reconstruction is now practically completed. We have unearthed fragments of two enormous Osiride statues and had been able to demonstrate that they had originally stood at the far ends of the two lowest porches of the temple."

The great story in the report on the 1928-1929 Egyptian Expedition is the finding of the tomb of Queen Meryet-Amun. After the search for statue fragments in the quarry and in the hole filled up by Thut-mose III, there was left only one more place where the archeologists believed that there was any likelihood of finds. On the hillside to the north of the temple there was a postern gate through which all sorts of rubbish and sweepings had been carried out in ancient times and dumped on the hillside. On it they noticed two chip heaps weathered during centuries and almost hidden by drift sand and fallen rock. Mr. Winlock says:

"We could see that the chip was shale from the lowest strata of the cliff and that it lay much higher up the slope than any natural agency could have carried it. Of course it was possible that we were dealing with heaps of shale dug out in leveling the temple courts below, but it was hard to see why the quarry chip from there should have been carried so far uphill—and across a ravine, at that. On the other hand it was equally possible that what we had were heaps of chip from the tunneling of some undiscovered tomb or tombs in the shale strata, and it was on this that we pinned our hopes.

"Naville had started to dig just outside of the temple wall—we had an old photograph showing some of his men working there—but he soon abandoned the place and covered the lower part of the slope with one of his inevitable dumps.

"AMONG the commonest questions put by the layman to the excavator is 'And how do you know where to dig?' If these words chance to fall under the eye of anyone who has wondered about it, an answer has been given for a typical case. In fact, the digging which took up the second half of our season involved finding the answers to so many of the everyday problems of excavation that it may be worth while telling the tale as we lived it on the spot. It had the usual delays and disappointments, the invariable surprise when the find was actually made, the laborious groping after the explanation of what had been found, and finally the arrival at a conclusion that seemed to fit the facts discovered. If the reader finds the tale involved in the telling he will get a very fair idea of the way things generally happen in the field."

The remainder of Mr. Winlock's story must be somewhat abridged, although we shall not depart from his own words.

"The gang of workmen was started at the foot of the hill. On February 23—six weeks after we had started—the men found a rough hole in the rock. They cleared out an irregular, jagged opening, and, when they were about waist deep, brought to light some rather carelessly laid brickwork. As a matter of routine we put guards on the spot.

"The bricks were merely stuffed into the mouths of an opening and were only held in place with a little clay smeared along the top. The pit itself was filled with dirt, rags, bits of a large white coffin, and the lids of straw baskets. Then we took out a couple of bricks and flashed an electric torch inside.

"IT was only then that we had our first hint that our tomb was not so simple and uninteresting. A jumble of white shawabti boxes and a headless Osiris figure could be seen just inside the opening. Beyond were several big round baskets to which the lids in the pit seemed to belong, piled against the wall of the corridor. Those big baskets were the kind usually associated with Eighteenth Dynasty tombs. Once our first surprise was over, we began re-adjusting our ideas. We jumped to the conclusion that we had found the tomb of another of Hat-Shepsut's courtiers.

"That night the tomb was sealed up again and heavily guarded. Then we started to remove the brickwork. One fact was soon established. Originally the corridor had been closed with a carefully built brick wall. All but the bottom courses of this wall had been broken down, and the tomb entered a second time, after which it had been reclosed with bricks and stones. Later all but three courses of this second blocking had been removed and the tomb entered a third time.

THE BRINK OF THE WELL
Here the empty outer coffin was dropped on the brink of the mysterious well

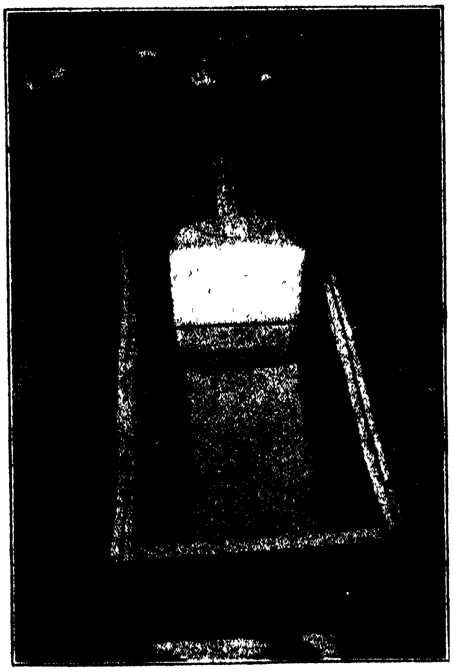
"The last people in the tomb had made a path along the corridor by pushing everything over to one side. On March 3rd I crawled in and gingerly followed in their footsteps. The passage was clear almost to the end, but there my way was blocked by a yellow, varnished coffin. Its lid was missing and inside it there lay a mummy with bandages absolutely intact and with garlands over its face and a wig at its head. Beyond it the lid of a large outer coffin was propped up on its side in a doorway leading to the right, and just beyond the doorway lay the empty outer coffin, the missing lid of the outer coffin, and the cover which belonged over the mummy itself. Here was a most surprising state of affairs. These coffins seemed to be lying just as they had been dropped by a burial party when something had interrupted them—and another flash of the torch showed what that something was. I was on the brink of a deep well that made an absolutely impassable gulf across the corridor. The real crypt of the tomb must lie beyond, and in the far left-hand corner across the well I could see a passage leading off to the left.

GIGANTIC
The problem of location being solved, masons "assembled" the statue of the usurping queen

"FOR the time we were completely balked. The Osiris figure bore the name of 'the House Mistress, the Chantress of Amen-Re, the King's Daughter of his body, his Beloved, Entiu-ny,' and the same name appeared on the shawabti figures in the boxes. From the style of the coffins we could safely conclude that we had discovered another daughter of Pay-nudjem, named Entiu-ny, who died and was buried probably in the years just preceding 1000 B.C. When Entiu-ny died, somebody had known of the existence of this tomb. The pit was dug out, the blocking broken through, and the heavy outer coffin and the three lids were started down the passage. As soon as the first bearers had turned the corner at the end of the corridor, they found themselves on the brink of the well, and dropped their burdens. The bearers crowding from behind with the body had to drop it. Probably a discussion followed, which ended with some of the party leaving the others while they went off to look for a beam to bridge the well. Some were left out of sight among the coffins long enough to chop the gilded faces off all three lids. We could picture them hiding their plunder under their clothes when they heard that no beams could be found. Bricks had been hastily stuffed into the entrance, leaving the Princess Entiu-ny lying just where she had been dropped on the brink of the abyss.

"It was the morning of March 11 before the well could be crossed. We brought down a light beam and worked it across the deep well to the doorsill on the opposite side. On the first we slid a second beam, and on the two, a board. I crawled across on my hands and knees, tingling with curiosity.

"From the doorway on the other side there was one step down, and then inky blackness. I turned on my torch and flashed it around. I was in a chamber just high enough to stand up in, seemingly interminably long in the gloom—and blankly empty. For a moment the bottom seemed to have fallen out of everything, and then my light shone on a narrow doorway at the far end. I came to a standstill just within the doorway beside three little empty saucers and a dried and shrivelled bundle of leaves lying at the foot of an enormous recumbent figure. My light flickered along it, and came to rest on a great placid face staring fixedly upward


THE HUGE COFFIN
The inner wooden coffin of Meryet-Amun in the big outer coffin after removal of lid

in the deathly silence of the dark crypt. Then it flickered back and followed down a column of hieroglyphs announcing that 'the King gives a boon to Osiris, the Great God, Lord of Abydos, that he may cause to come forth at the call, bread and beer, beef and fowl, bandages, incense and unguents, and all things good and pure on which a god lives, and the sweet north wind, for the spirit of the King's Daughter and Sister, the God's Wife, the King's Great Wife, joined to the Crown of Upper Egypt, the Mistress of the Two Lands, Meryet-Amun, true of voice with Osiris.'

"On the 15th we raised the gigantic coffin lid and exposed a disproportionately small coffin inside. That was open, and we were looking at a slender little mummy, simply wrapped, and festooned with garlands still fresh enough to show the colors of their flowers. The inner coffin, while much smaller, had been almost as lavishly decorated. On the head we found a tenon hole which had once held the golden vulture head of a queen's crown, and all over the body were rows of nail holes showing that within and without the entire coffin had been encased in sheets of gold. None of this richness was left, however. In place of the vulture head on the brow a uræus had been painted; the wig was colored blue and the face yellow; a blue and yellow collar had been daubed over the breast; down the front was painted a copy of the inscription on the big coffin.

"WITH obvious signs of forcible opening on both coffins, we have a pretty clear story. At some time in antiquity, the tomb of Meyret-Amun had been robbed, and on the discovery of the outrage all that was possible had been done to cover up the damage. The date had been recorded in a docket; that second blocking of the doorway must have been done in 1049 B.C. by the necropolis officials who restored Meryet-Amun's mummy. So far we were still leaning toward our first idea that this tomb had originally belonged to Hat-Shepsut's courtiers. It was only when we had cleared the last of the rubbish out of the tomb that we changed our minds. A pile of rags had been thrown into the unfinished corridor to the left of the well. They turned out to be bandages ripped off a mummy, and among them we found one marked 'The God's Wife, the King's Wife, Meryet-Amun, beloved Amun. May she live!' These, then, were obviously the original bandages torn off Meryet-Amun's mummy by the thieves.

"Among other fragments of funeral furniture were bits of an enormous wooden coffin plastered over with white gesso. It had been actually big enough to hold the great coffin of Meryet-Amun. Here was the third outermost coffin of Meryet-Amun so completely wrecked by the thieves it had simply been swept out of sight at the time of the restoration. It followed that Meryet-Amun had been robbed here in this tomb. Thus we arrived at the conclusion that we had discovered the tomb of Queen Meryet-Amun.

"In the first corridor two things gave us a very good idea of the period when the tomb was constructed. That corridor passed obliquely under the north portico of the temple so close that the under side of the temple foundations was actually exposed in one place in the corridor roof, hanging precariously over our heads. Now it is possible to dig under foundations once they are set, and even to expose them without necessarily bringing them down, but it is absolutely impossible to lay heavy stones unsupported across a void. Thus the tomb must have been made after the middle of the Eighteenth Dynasty, when the temple was built. Therefore, we felt safe in dating the tomb of Meryet-Amun to the second half of the Eighteenth Dynasty, and her coffins confirmed this date absolutely. Meryet-Amun could not have been buried earlier than 1480 B.C., when the temple was finished, and probably not much later than about 1440 B.C. The only question that remained was to settle the identity of Meryet-Amun herself. Two queens of that name were known, but our queen could be neither. There remained a Princess Meryet-Amun—'the King's Daughter, the King's Sister, the God's Wife and Hand (-maiden?), sweet in love, living like Re''—portrayed in the Shrine of Hat-Hor erected at Deir el Bahri by Thut-mose III. This Meryet-Amun was the ranking daughter of Thut-mose III and of his Great Wife, Meryet-Re'. The Princess Meryet-Amun, the daughter of Thut-mose III, must have been the wife of his heir and successor, Amen-hotep II. Since Amen-hotep II succeeded in 1447 B.C., and as we already had evidence to place our Queen's death somewhere between 1480 and 1440 B.C., we felt convinced that the two Queens Meryet-Amun were one and the same person. During her father's lifetime she had been 'the King's Daughter.' After his death she had become 'the King's Great Wife.' But the last title—'the King's Mother'—had never been hers. She must have died soon after the coronation, for Queen Ti-'o occupied the position during most of Amen-hotep's reign. Of Meryet-Amun, no recognized trace existed until we found her tomb.

ORIGINALLY GOLD COVERED

Once of a richness comparable to the coffin of Tutankhamen, but vandals have completely stripped off the decorations

"KNOWING now, with fair assurance, who Queen Meryet-Amun was, we can complete the story of the tomb. Work was begun on it at least as early as her coronation but it was still unfinished when she died soon afterward. There was no time to hew out an actual burial crypt and her gigantic white outermost coffin was installed in the last of the unfinished passages beyond the well. On the day of her funeral came the enormous coffin overlaid with gold and brilliant with incrustations, the little innermost coffin just large enough to hold the mummy, and the mummy itself heavy with jewelry within its bandages. The coffins were closed, the richest of the tomb furniture was placed nearby, the bridge across the well was removed, and the baskets full of the less valuable clothing and food were stacked in the outer corridors. Then the entrance was carefully bricked up and the pit filled in—and Meryet-Amun lay in peace for the next four centuries."

Submarine Safety Advances

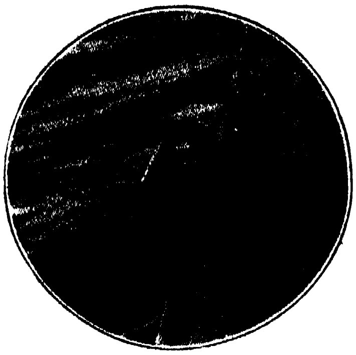
The "S-29" Is Now a Floating Laboratory for Testing Sub-Sea Safety Devices

SINCE 1923, eight United States submarines have been in serious accidents. Only three of these resulted in death to members of the crews but the great hazard of submarines to which all these disasters pointed served to accentuate the widespread insistence that safety measures be taken and safety apparatus be devised to protect, and save in case of trouble, the lives of submarine crews.

Loss of the *S-51*, on September 25, 1925, with five officers and 31 men was appalling enough but when the *S-4* was rammed and lost on December 18, 1927, with her entire crew, matters were brought to a head. The government renewed its submarine safety efforts in earnest. Thousands of ideas were submitted by scientists, engineers, inventors, and laymen. Most of these were quickly discarded but others were considered further; some have been worked out and tested, and a few are still being experimented with.

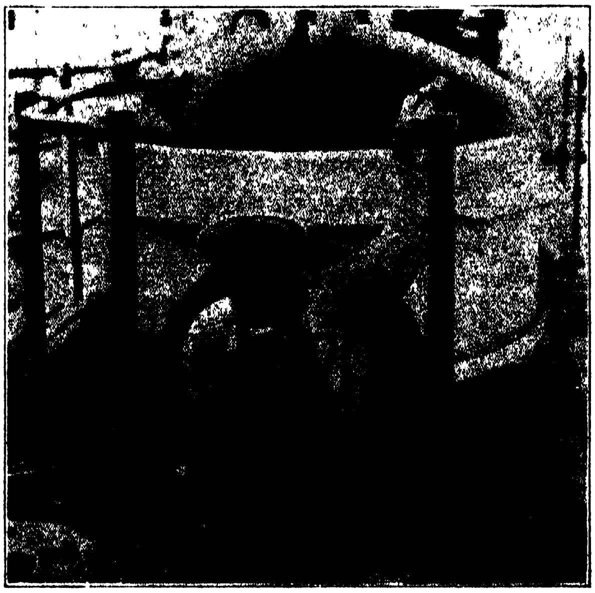
PERHAPS the most valuable device recently developed in this country is the Momsen "lung," an illustration of which is shown on this page. Named after its inventor, a lieutenant in the United States Navy, this lung is, in effect, a miniature diving apparatus which, when worn, permits the wearer to rise safely from a sunken submarine without danger of suffocating or drowning. This and the other devices shown here are installed on the submarine *S-29* which recently arrived in San Diego Harbor equipped with all the latest rescue and salvage devices. These devices will be tested this winter and early spring.

It has been asserted that submarine design and construction in the United States has been far in advance of that of other nations and our accidents fewer than in any other comparable navy. Not content with this high place, government experts are continually working to devise new safety apparatus and to improve the old.



LIFTING EYE

The eye on the hull of a submarine for attaching a pontoon

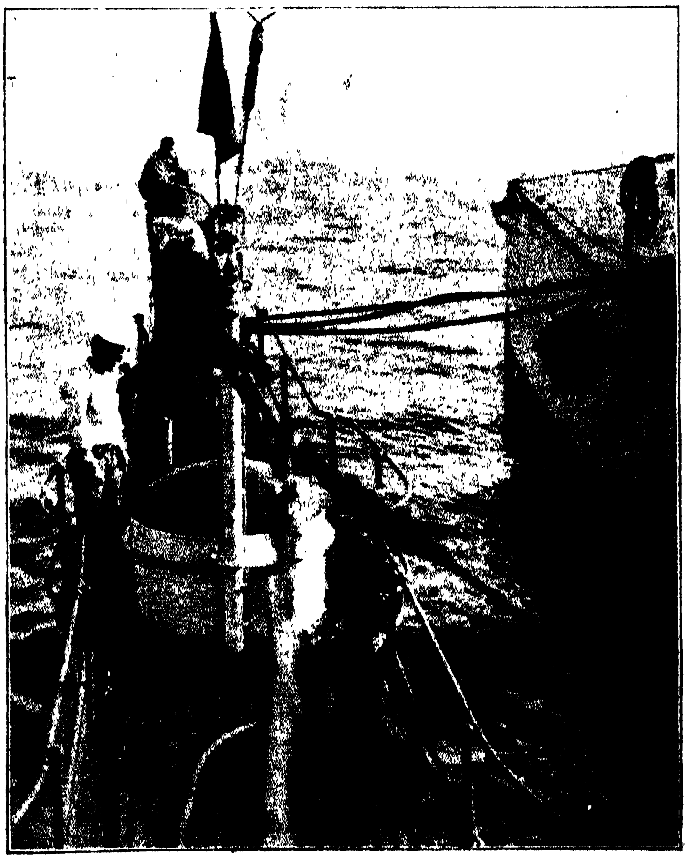


MOMSEN "LUNG"

The breathing mask which men will use to escape sunken submarines

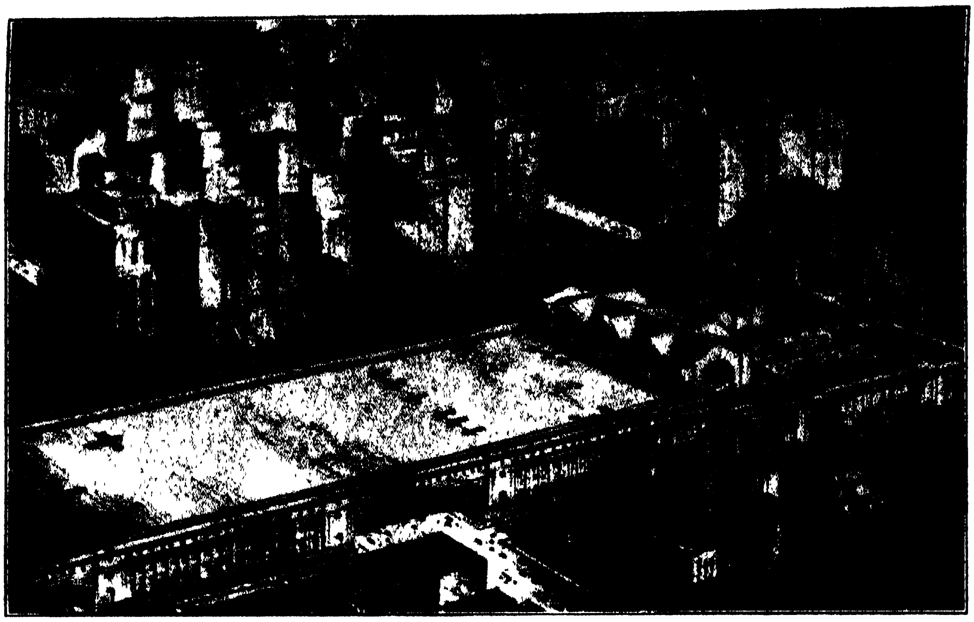
UNDERSEA COMMUNICATION

A member of the crew of the submarine *S-29* demonstrating the use of buoy telephones for talking with a sunken submarine



THE ESCAPE HATCH

This view taken from the conning tower shows an escape hatch and the buoy which carries a telephone line to the surface



IN THE HEART OF THE CITY

Planes landing on this platform "field" over the Pennsylvania Railroad tracks in New York City, conceived by Francis Keally, could discharge their passengers directly in the city while their mail could be shot directly to the branch post offices in the city by pneumatic tubes

Faster Airmail Terminal Service

Pneumatic Tubes Like Those in Cities Between Branch Post Offices Would Speed Airmail Between Post Offices and Airports

By HAMILTON M. WRIGHT

PNEUMATIC tube service for airmail from outlying airports into the post offices of large cities has been urged by a number of architects, engineers, aviators, post office officials, and others who, in the past two years, have given thought to the problems of aviation and particularly to the expedition of the airmail. Since the dispatch of airmail is the backbone of commercial aviation in this country, and since the airmail is constantly assuming larger proportions, any means which will improve this new branch of the postal service is worthy of careful analysis. The present importance of airmail is illustrated by the fact that the scheduled daily mileage of mail pilots in June 1929 was 38,689 miles! But this is only a beginning. Important postal officials have predicted that in a very few years *all* first-class mail will be carried by air.

Unfortunately for aviation, obstacles dangerous to fliers exist in the vicinity of large cities so that mail-contract airports are necessarily located at some distance from post offices and commercial centers. These suburban locations place air terminals at a disadvantage as compared with railway terminals which are much nearer the post offices.

A pneumatic tube for carrying mail between airports and post offices would, however, offer safe, economical, uninterrupted, and rapid service. It is, of course, essentially adapted to large cities where the amount of mail is vast and where the airport is, generally speaking, six to 15 miles distant from congested centers. Other means to overcome the handicap of airports have been suggested, such as dropping the mail from parachutes into nets, building landing stages on the roofs of tall city buildings, or constructing elevated landing platforms above switching yards or wharves in cities adjacent to commercial centers. All these, however, are inherently more or less uncertain or dangerous, and even a helicopter plane, it is said, would not find the proximity of large city buildings conducive to complete safety.

THERE is a great inconsistency between the 100-mile-per-hour, or more, rate of fliers to carry the airmail on time and the slow truck traffic to the distributing centers. It takes a bus 45 minutes to run between the Newark airport and the Hotel Pennsylvania opposite the main New York Post Office.

This sort of delay, to a greater or less degree, but always to an important extent, will occur where trucks must be employed to carry mail between airports and post offices through congested areas of great cities. The red stop light traffic signal is no respecter of vehicles, not even of mail trucks.

The Joint Commission on Postal Service which from 1921 until 1924 made an exhaustive study of the postal system, reported to Congress that on one day that was studied 27,166 mail containers with a capacity of 10,846,400 letters were dispatched through the pneumatic tubes in New York City, and that, for each letter delayed by the tubes, 3915 letters were delayed by the motor vehicle service. They also said that the operation of the tubes and the reduction of the motor vehicles service would reduce the number of accidents in congested streets of New York which, in 10 months, resulted in seven cases of fatal injury and 99 cases of other injuries caused by government-owned vehicles.

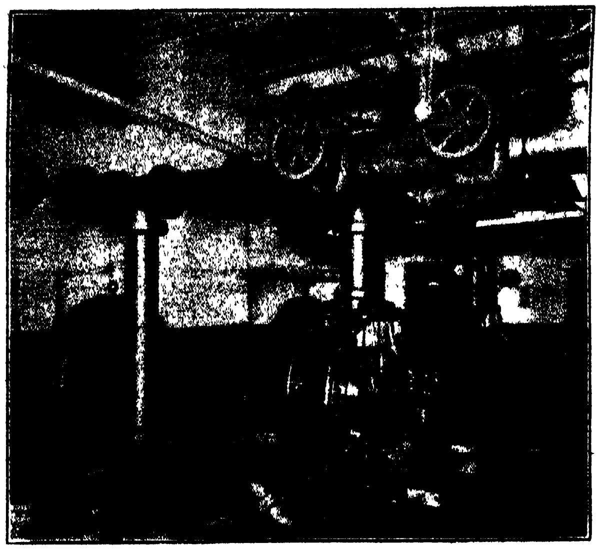
Other points were that the pneumatic tubes as a means of transmittal of the mails are secure and reliable; that the delivery of letters is expedited from two to four hours or more by utilization of the tubes, and that the speed of transportation by tube is 30 miles per hour, whereas the speed of transportation by motor vehicle in New York is but 7½ to 10 miles per hour; that approximately half a million letters a day would be advanced in delivery by means of the tubes; and that the tubes have a value apart from speeding the mail, in that they stand ready at all emergencies and are not subject to the irregularities experienced by the motor vehicle service.

Largely as a result of this report, the pneumatic mail-tube service was resumed in New York and has given excellent results. Letters are now carried more than 140,000 carrier-miles per day beneath the streets of New York, equal to a daily journey of five and two thirds times around the world. The "petit bleu" pneumatic tube service for special delivery mail in Paris is too well known to any experienced visitor there to require any description. Pneumatic tube service also exists in London, Liverpool, Berlin, Vienna, and other cities.

In New York City the pneumatic tube system consists of 27½ miles of double tube extending between the Battery and 125th Street on both sides of the city, and across the Brooklyn Bridge to the Brooklyn Post Office. There are between four and five miles of double tube in Brooklyn.

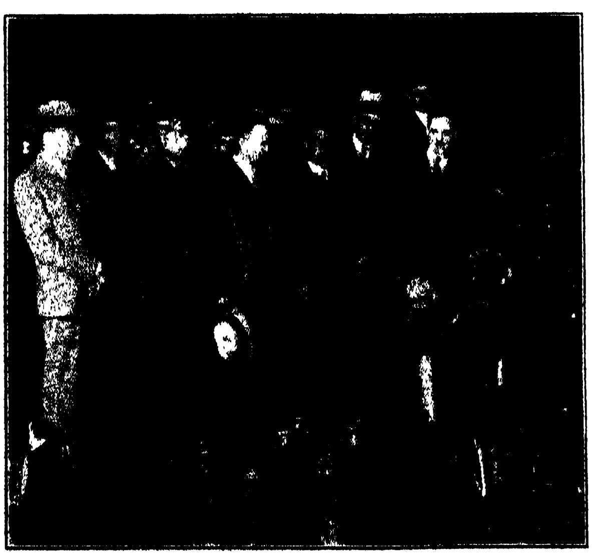
In New York the operation has reached a remarkably high stage of efficiency. The efficiency of service for several years has averaged better than 99 percent. Interpreting the figure 99.9661 percent for 1928 a typical year —we see that the pneumatic mail-tube service in New York City was within one twenty-fifth of 1 percent of perfect operation. The saving in time in the arrival of mail at its post office destination to reach early mail carriers and for outgoing mail to reach departing trains is one of the outstanding advantages of the system. This advantage could as readily be transferred to the dispatch and receipt of airmail.

The cost of constructing a pneumatic tube system similar to that in New York is estimated at approximately 19,500 dollars per mile. It would cost, therefore, approximately 195,000 dollars to install the system between Barren Island, New York City's new municipal airport, and the Brooklyn Post Office. But the tube would pass five post offices en route and give important factory districts the same mail service that Wall Street now enjoys. Installation of smaller sized tubes like those used in Berlin--for example about 2¼ inch—would cost less for less important airports. The tube system in New York is privately owned, the owners contracting with the government for the handling of mail. According to the majority report of the Townsend Congressional Committee, their use effected a saving as compared to mail trucks.



BROOKLYN AIR POWER STATION

Electrically driven compressors and rotary blowers which supply air to the tube system in Brooklyn



TUBE MACHINERY

Clarence Chamberlin, consulting engineer for the Barren Island airport, who advocates a mail tube system between the port and New York City, inspecting the pneumatic tube machinery at the General Post Office, New York City

Just a word as to construction of the tubes. They are made of sections of cast-iron pipe approximately 12 feet long, bored out to an inside diameter of 8⅛ inches - designated as 8-inch tubes—and joined together with bell and spigot joints caulked with lead or other suitable material. Change of direction in the tube is accomplished by sections of tube bent to a long radius at true curvatures to permit the containers to slide along without reduction in speed.

The tubes are laid approximately four feet underground between stations.

The containers in which the mail is packed are steel cylinders, 7 inches in diameter and 21 inches long (inside dimensions), and weigh approximately 20 pounds each when empty. The front end of the container is solid and is equipped with a leather buffer designed to absorb the impact when the container is brought to rest. The rear end of the container is a hinged cover, which is opened for the insertion of mail and which, after being closed, is locked by means of an eccentric lever connecting with inside bolts which engage the rim of the cylinder in suitably designed slots. When the cover is unlocked this lever projects beyond the edge of the outside periphery of the cover, thus preventing the container being placed in the tube until the cover is properly locked.

The shell of the container is kept from contact with the tube by means of two bearing or packing rings located near the ends of the container, composed of cotton, duck, and vulcanized rubber, and held in place by keeper rings brazed to the shell of the container. The container slides in the tube on these packing rings, and the tubes are lubricated from time to time to facilitate the passage of the container. The power which propels the containers through the tubes is a current of air which is maintained constantly through the tube at a pressure of from four to eight pounds per square inch, according to the length of the line, by electrically driven air compressors and rotary blowers.

Each station on a pneumatic-tube line is equipped with a receiving and sending apparatus, commonly called a "receiver" and a "transmitter," and the containers are relayed at each station on the line until they reach the station of delivery.

Different types of "receivers" and "transmitters" are used, the receivers being divided into two general types—the "open" and the "closed." With the open receiver, the container is brought to rest by the friction created in its travel around a circular table or trough formed of a half longitudinal section of tube bent to the desired radius. With the closed receiver the container is brought to rest by the compression of air in the dead end of the tube forming an air cushion which, in turn, opens a valve and ejects the container. The "transmitter" most commonly used is of the gravity type, set in the floor at an angle.

The container is dispatched by placing it in a scoop or trough with its front end resting against the upper gate. This gate opens at the interval of time fixed by a time clock, allowing the container to drop into the air chamber. Air pressure is then brought behind the container, forcing it through the lower gate and into the tube, where the current of air carries it to the next station. The system is similar to a stream of water into which floating objects are dropped at stated intervals.

What's In the Sun?

Not Only What Elements Exist in the Sun's Atmosphere, But Now Their Percentages, Have Been Worked Out by Improved Analysis

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

WE told last month how, by measuring the width of lines in the solar spectrum, it is possible to find how many atoms are at work above a given area (say a square centimeter) of the sun's surface in absorbing each particular line. Many readers doubtless realize the possibility of using this method for an improved analysis of the composition of the solar atmospheres. The older method which depended merely upon the identification of solar lines told us only what elements were present there. It was like the qualitative analysis with which the student of chemistry begins—very like it indeed, for these tests in the laboratory give the student an idea whether a given metal is present in large quantities, small quantities, or mere traces, and the same can be concluded from the presence of strong lines, weak ones, or very faint ones in the sun.

But the chemist will not be satisfied with this information. He devises schemes for quantitative analysis which end by telling him the exact percentage composition of the substance he had studied. To do the same for the sun and perhaps also for the stars has long been one of the dreams of the astronomer. Now the dream is coming true.

FIRST steps were taken by Professor Milne (now at Oxford) who devised ways by which the composition of different stars could be compared, even though some were hotter than others. Miss Payne, working at Harvard by this method, found that the numerous stars which she studied were "remarkably similar" in composition, and obtained good estimates of the relative abundance of a considerable number of the more important elements. Now the analysis has been carried further and applied to all the 57 elements which have been detected in the sun's atmosphere.

At first sight the problem looks simple enough. If we can measure the width (technically speaking, the "contour") of one line and calculate how many atoms are at work making it we can do so for all the 20,000 lines in the solar spectrum. Then, adding together the results for all the lines of iron (for example) we have the amount of iron in the sun's atmosphere.

But it is not really quite so easy. In the first place the finer lines are so narrow that even our greatest spectroscopes lack the defining power to show them perfectly; they make them look wider and less black in the middle than they really are. Moreover, influences in the sun's atmosphere may widen the lines slightly—not enough to count for a strong line but quite enough to upset our calculations on a weak one. Fortunately there is an easy way to get around this difficulty. There are hundreds of groups of lines—"multiplets"—in the spectrum for each of which we can calculate theoretically the relative number of atoms at work. For example, twice as many calcium atoms are "doing" the K line as are at work on the H line. In other cases the rate runs up to 100 or even 1000.

Courtesy Yerkes Observatory

SOLAR SPECTROSCOPE

Attached to the great 40-inch refractor at Yerkes Observatory. A more or less "typical" instrument for work on the sun

BY utilizing the rich material thus available it is obviously possible, and was not very difficult when it was tried, to find the relative numbers of atoms which were required to produce lines of different intensities on the arbitrary scale which Rowland used in the great tables of the solar spectrum. We already have, thanks to Unsöld, determinations of the actual numbers of atoms at work on a dozen or so of the stronger lines. With this starting point we can now find it for all the rest.

For the lines which Rowland described as of "intensity 0," that is, those which were just strong enough on his photographs to measure easily, the number of atoms at work comes out at 6,000,000,000,000 (6 x 10^{12}) above every square centimeter. This looks startlingly big, but a layer of ordinary air 1/1000th of an inch thick contains 6 x 10^{12} as many molecules per square centimeter. So we reach the amazing conclusion that to produce one of these faint solar lines would require only a layer of gas 10,000 times thinner than air and a thousandth part of an inch thick, provided of course that all the atoms of this gas were at work on the line. Remarkable as this is, it is fully credible to anyone who knows the extraordinary delicacy of the spectroscopic method of analysis, which habitually reveals traces far too small to be detected by ordinary chemical means.

THE general run of the strong lines of the spectrum for which Rowland's intensity numbers range from 7 or 8 up to 40 demand for their production from 1000 to 20,000 times as many atoms; the H and K lines, which are vastly stronger than any other, about a million times. For the faintest line (of intensity −1 to −3) the number varies from 30 percent to 2 percent of the standard.

We have now overcome this obstacle and can calculate with some confidence how many atoms produced each line. We should be near our goal if the whole extent of the sun's spectrum could be observed.

But this, though it might be possible if we could set up an observatory on the moon, is out of the question for us who dwell on the earth. The atmosphere above our heads, although reasonably transparent to the kind of light which our eyes can see, obstructs the passage of most others. Not very far beyond the range of ordinary observation in the violet, and hardly at all beyond the limit to which the human eye can see under favorable circumstances, the air becomes opaque. For waves of light shorter than about 3000 Angstrom units (the ordinary violet is at 4000) our air transmits not the faintest trace of the rays, which we have no doubt at all that the sun emits and emits strongly.

We know what is to blame—a small proportion of ozone in the upper atmosphere higher than any aircraft or even a pilot balloon may hope to rise. Beyond the wavelength limit mentioned, down through the whole range of shorter light waves, all direct knowledge of the radiation of the sun and stars is permanently denied us.

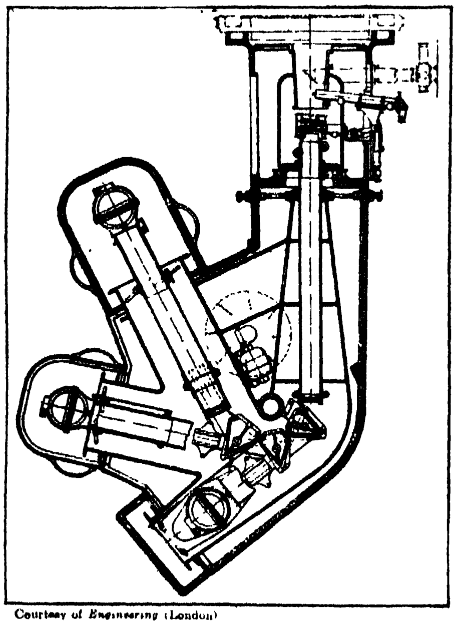
Beyond the red end of the spectrum things are not quite so bad, but there are wide and heavy bands of absorption, due mainly to water vapor, which cut off great regions of the spectrum, and the rest can be observed only by heat-recording devices which, sensitive as they are, are vastly inferior to the eye or the photographic plate. Only the portion of the spectrum between 3000 and 11,000 Angstrom units is accessible to precise astrophysical study.

If, then, an element has practically all its strong lines in this accessible region we will obtain a correct determination of the amount of it in the sun's atmosphere. But if not, our estimate will be too low and may be altogether vitiated.

A few years ago, before the structure of the more complex spectra was understood, this difficulty would have been insurmountable. But now we know for a large majority of the spectra not merely what sort of atom produces the lines but in what state the atom has been to absorb any given line. Some are given by neutral atoms, others by ionized atoms which have lost an electron. Some are produced by atoms in their normal state, others only by atoms which have been "excited," that is, loaded up with an additional store of energy and so raised to one or the other of a large number of additional states. The great majority of the atoms of any one element at any instant will be in the normal state, but a certain proportion will be in each of the excited states. This proportion can be calculated if we know how hot the sun's atmosphere is—which fortunately we do pretty well. For some of the metals such as iron and titanium the strongest lines absorbed, both by the normal state and several of the excited states, are accessible. We can then find the number of atoms in each of these states and the results check with the theoretical calculations closely enough to indicate that it is really safe to apply the theory (which was devised under the assumption of simple idealized conditions) to the actual atmosphere.

THE "abundance," that is, the number of atoms above a square centimeter of the sun's surface, may then be found for a large number of the metals. For some of the others, such as magnesium, the lines absorbed from the normal state are practically all in the ultra-violet and inaccessible, but the lines of the excited atoms remain to work with, and having tested our method we can calculate the whole number of atoms with confidence. Indeed we can get a good idea how strong the principal lines of these elements would appear if we could get outside the earth's atmosphere and look at them. There is a great line of magnesium, for example, at λ2852 (just inaccessible) which must be even stronger than the H and K lines.

So far we have really been talking only about the arc lines, those of the neutral atoms. The ionized atoms must be handled separately but can be treated quite in the same way. In most cases the "ultimate" lines absorbed by the ions in their normal state are quite out of reach, but there are several elements—calcium, titanium, and so forth—for which we can get at them. In these cases we can find the whole number of ionized atoms, as well as that of the neutral atoms. Now the latter of these two depends not only on the temperature of the sun's atmosphere but also on the average pressure; and also, of course, upon the ease of ionizing atoms of each sort. It thus enables us to calculate this average pressure. The results, calculated independently from five different elements, agree satisfactorily.



Courtesy of *Engineering* (London)

A TYPICAL SPECTROGRAPH

Made by Hilger for the new 36-inch reflector for Edinburgh Observatory. Cross-section shows heat-insulated case, motor-driven fan for even air distribution, three prisms, and three cameras. Note hole for main pivot. This permits moving any camera to any part of spectrum

We can now handle one more situation which previously was intractable. Sodium, for example, is very easily ionized, but the principal lines of the ionized atoms are far out in the inaccessible region, and so the amount of ionized sodium can not be found by our spectroscopic analysis. Knowing, however, the average pressure, we can calculate it, and it comes out 1600 times as great as that of the neutral element. The familiar D lines of sodium in the yellow, then, although they are strongest in this part of the spectrum, must be mere wraiths of what we would see if the sun's atmosphere were cooler and the ionization much smaller.

Working step by step it has finally been possible to obtain a complete quantitative analysis of the sun's atmosphere with respect to the metallic elements.

The non-metals are much harder to handle, for their ultimate lines are utterly out of reach, and the only lines we can get at are produced by highly excited atoms. Theoretically, at the sun's temperature not one atom in a million should get into such a state. Various factors of which it is not yet practicable to take exact numerical account may, however, operate to modify this number. The fact that these high excitation lines are present at all in the sun, although faint, shows that the corresponding elements, oxygen, carbon, sulfur, and so on, must be very abundant, but only the roughest numerical estimates can be made. Hydrogen is remarkable, for its lines, although absorbed only by very highly excited atoms, are among the strongest in the whole solar spectrum. There can be no doubt that it is much more abundant than any other element—if we count atoms by number, and light as its atoms are, their total weight probably exceeds that of those of any other sort.

AN investigation recently completed by the writer leads to the following estimated composition of the sun's atmosphere:

	Parts by Volume	Parts by Weight
Hydrogen	60	60
Helium	2?	8?
Oxygen	2	32
Metallic vapors	1	32
Free electrons	0.8	0.0005

The numerical values just given may be considerably changed by future work, but the hydrogen flavored with oxygen and metallic vapors seems likely to stand.

The amounts of the various metals can be stated with much more confidence. Expressed in grams per square meter of the sun's surface the amount of the principal metals are:

Sodium	40	Scandium	0.02	Cobalt	2.5
Magnesium	150	Titanium	0.8	Nickel	4
Aluminum	6	Vanadium	0.5	Copper	0.6
Silicon*	60	Chromium	2.5	Zinc	0.5
Potassium	25	Manganese	4	Strontium	0.015
Calcium	20	Iron	100	Barium	0.025

No other metal reaches as much as 0.01.

Many conclusions might be drawn from this table but there is no space to speak of them now.—*Florence, Italy, Nov. 3, 1929.*

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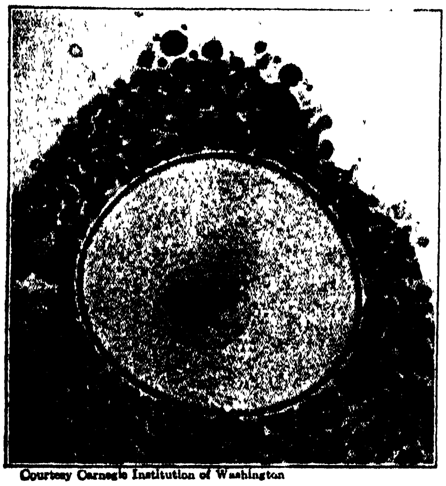
*Silicon behaves spectroscopically like a metal.

How Large Is the Human Egg?

Some of the Findings of Recent Research Upon the Eggs of the Human Species, and Those of Other Mammals

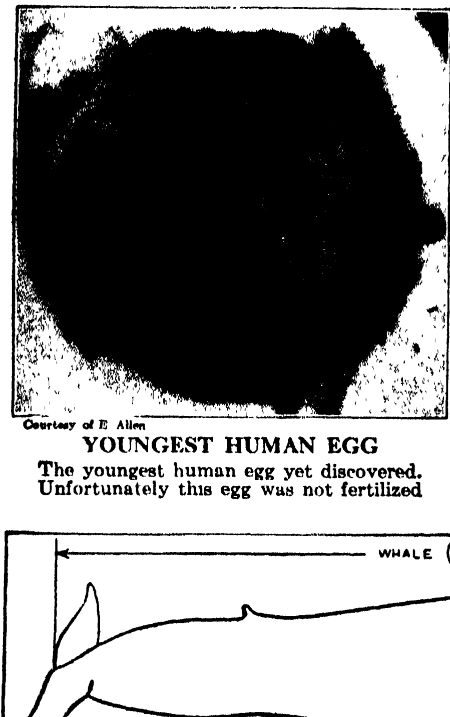
By CARL G. HARTMAN, Ph.D.
Research Associate, Department of Embryology, Carnegie Institution of Washington
Carnegie Laboratory of Embryology at Johns Hopkins Medical School



Courtesy Carnegie Institution of Washington

A HUMAN EGG

The egg is surrounded by nurse cells in the ovary. The view is a cross-section



Courtesy of E Allen

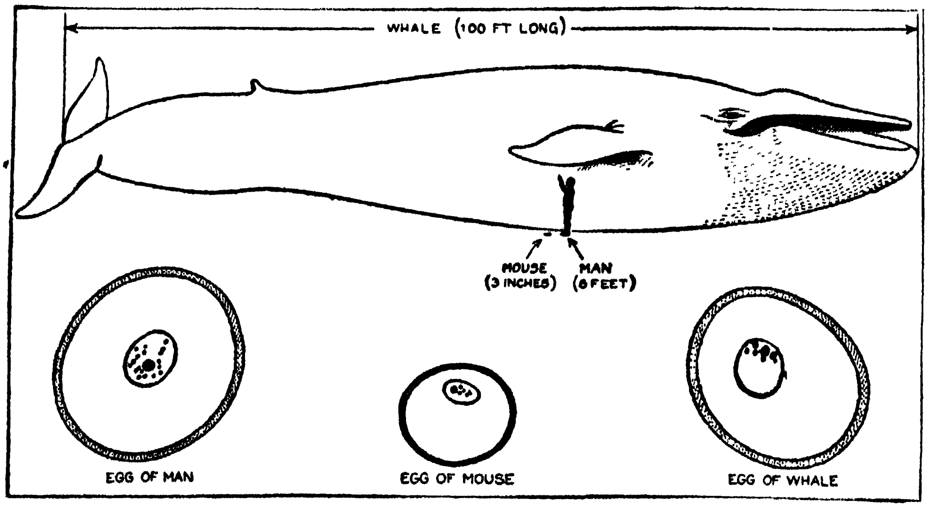
YOUNGEST HUMAN EGG

The youngest human egg yet discovered. Unfortunately this egg was not fertilized

THAT there is such an object as an egg, wherein every human being has his origin, no longer astonishes the layman. Few people, however, realize the minuteness of this all-important microcosm, which is pretty near the borders of unaided human vision. To gain a concrete notion of the size of a human egg, scatter a pinch of sea sand over a sheet of black paper and find the smallest visible grain. This is of the order of magnitude of a human egg. Yet this egg is larger, by a fraction, than most mammalian eggs—it is about double the size of those of the mouse or the rat, which are the smallest, and larger than that of the horse or the cow. But such differences are not significant.

It is no wonder, therefore, that the egg of mammals should remain undiscovered so long, for it was not until the year 1827 that von Baer, a Russian biologist working in Germany, was able to point out the egg of mammals and to tell us something of its size and where in the ovary it was to be found. This marked an epoch in the study of human and animal life.

Throughout the hundred years following, many mammals were studied, rabbit eggs being especially singled out. This was for biological reasons and not because of the traditional activity of the Easter Bunny—the legend of Mother Rabbit is older than any scientific studies upon her. Rat, mouse, dog, cat, pig, and other species have yielded eggs in greater or lesser abundance, according to the difficulty of finding the eggs in any given animal species, and depending upon the perseverance and ingenuity of the investigator.



WHALE EGG, HUMAN EGG, MOUSE EGG—ALL ABOUT EQUAL SIZE

All the mammals have eggs of approximately equal size. The whale, largest mass of flesh controlled by a single brain, originates in an egg little larger than that of a mouse

As a result, we know pretty well what happens during the first few days after conception in a half dozen species of animals; indeed, it has been possible to record in motion pictures the changes of the rabbit egg during the first five days of its development.

Until last year no one had ever succeeded in finding a freshly shed human egg, although a year and a century had passed since von Baer first saw the human egg in the ovary. The fact remains, however, that, except by analogy with animals, we know almost nothing about the development of a human being during the first 12 days of embryonic life. This hiatus in our knowledge bids fair to be filled within the next few years.

THE small size of the mammalian egg demands an explanation. It is the smallest egg of all the vertebrates, yet mammals are among the largest animals that ever walked the earth or swam the seas. By way of contrast, the ostrich egg measures six inches in length and holds a quart of food for the ostrich chick; a certain man-eating shark has an egg eight and one half inches in diameter; the eggs of snakes and turtles, fishes and frogs, possess yolk and egg-white to nourish the developing embryos, so that upon hatching they can survive in a new environment. The mammal embryo, however, and even the egg before the appearance of the embryo, has learned to parasitize the mother directly. Not content to consume the food which the mother's organs place into the egg (as is the case in the bird, for example), the mammalian embryo "digs in" and lives at the expense of the mother's body. It effects its purpose by growing a system of blood vessels and laying them down next to those of the mother's womb. There food and waste substances are exchanged, and there the embryo may remain during a variable length of time until birth.

There are some exceptions to this rule for mammals—links, as it were, in the evolutionary chain. There are, for example, the curious monotremes of Australia, that land of biological surprises—two genera: *Ornithorhynchus*, or the duck-billed platypus, and

THE author of the accompanying article modestly has made little or no direct mention of his own part in the newer research on the living egg of the mammal. The especially interested student will find a technical study of the subject, with further bibliography, by the same author, in the *Quarterly Review of Biology* (Baltimore) Vol. IV, No. 3—*The Editor.*

Echidna, the Australian ant-eater. These mammals actually lay eggs: the ant-eater deposits an egg into a brood pouch on her abdomen; the duck-bill lays a pair of eggs in its nest where it incubates them like a hen. Comes a time for the young to hatch. These wiggle about the milk glands of the mother, setting up an irritation that results in the milk oozing out. This the babies lap up, for these mothers have no nipples. Since they have mammae, or milk glands, it must be admitted that they are mammals, but the mammae have only just "arrived."

Next in the evolutionary series are the marsupials, which, as the name implies, have abdominal brood pouches like the *Echidna.* Our American curiosity, the opossum, is our only marsupial; the others, like the kangaroo, all live in Australia. The marsupials no longer lay eggs; their eggs are reduced in size like those of other mammals, but are provided with eggwhite and a shell membrane. These increase the size of the egg so that only 50 can be laid in a row to make an inch, instead of 170 without the envelopes. Of the full-sized eggs with the envelopes, a thimble would hold no more than 15,000. The opossum eggs are beautifully transparent things when well illuminated under the microscope. Magnified, they look like delicate soap bubbles or spheres of blown glass.

The opossum embryo develops in the mother's womb for only a short time—it is not yet an expert in parasitism. After only 12 or 13 days the babies must be born; tiny bits that they are, 18 of them will just comfortably fill a teaspoon. But Nature has its compensations; it has provided a brood pouch on the mother's belly around the tiny udders. Here food, warmth, and shelter for two months bring the babies to where their eyes are open and their legs are strong.

A PEG higher in the scale come the rabbits. Their eggs have no shell membrane, but they still possess a large amount of egg white, like their contemporary ancestors, the marsupials. All other mammalian eggs, including the human, have lost the egg white and are tiny spheroids of protoplasm. They have become much alike. There are minor differences: the opossum egg has more fat, the dog egg is opaque, while those of the mouse and rat are very transparent. Fundamental differences doubtless exist but they are not discoverable by present means. All rabbit eggs look alike, yet if you take the eggs from a black rabbit and place them in a white mother, the offspring will all be black.

Perhaps the differences between a mouse egg and a whale egg are as great as between adult mice and whales, but size is not one of the characteristics wherein they differ. From the Greeks to the moderns, philosophers have theorized on this point, but their theories are of historic interest and belong to the realm of metaphysics, not biology.

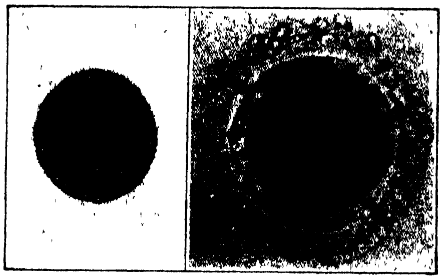
To visualize still better the minuteness of the eggs of mammiferous quadrupeds, let us single out the human egg and make another comparison. Let us assume that the entire human race comprises in the aggregate two billion individuals. Suppose one could assemble in one place all of the eggs from which will arise the next generation of mankind - 2,000,000,000 eggs. How much space would they occupy? Would they amount to a houseful, or a roomful, or a hatful?

The last guess is right—a derby hat would suffice. The largest egg known to science is that of the recently extinct Madagascar bird, the *aepyornis* an egg over a foot in length. This largest of vertebrate eggs will hold 2,000,000,000 of the minute eggs of mammals. The largest mass of animal flesh that ever lived as an individual, controlled by a single brain, is the whale; yet the eggs of mouse, man, and whale are approximately of equal size.

NOW each human egg, before it can develop, must be "fertilized" by a male cell or spermatozoon. Male sex cells are tremendously smaller than the eggs: the 2,000,000,000 of them necessary to fertilize the eggs from which will come the next generation of mankind would easily go into an elliptical vessel the size of a capital letter "O" on the text page of this magazine.

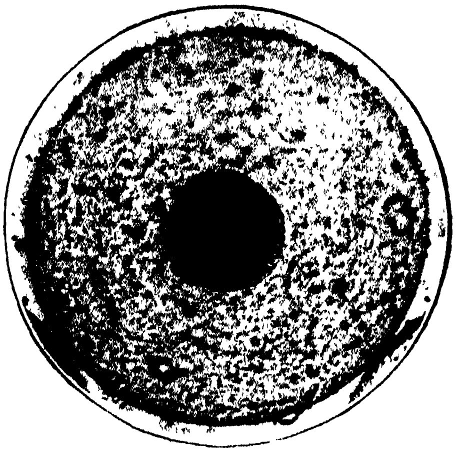
What a microcosm is such a fertilized egg, carrying as it does all the hereditary qualities from both parents that make the individual, into whom it develops, what he is! It is an entity in size somewhere near half way between the electrons and "corpuscles" of which matter is composed and the vastness of space known to the astronomer. Yet in the fertilized egg is bound up the capacity to develop into the complex mechanism of the human body; it has represented in it, perhaps by actual molecules capable of infinite and eternal multiplication, all the characters which the individual inherits from his parents, his grandparents, his ancestors back through the vistas of time, racial and familial—color of skin, hair, and eyes; stature and constitution; temperament and character. These myriads of factors are, moreover, represented, not in the whole egg but only in its tiny nucleus, which, in its turn, contains those self-perpetuating molecules, the genes, that determine at fertilization what each individual shall be.

Truly the unfolding of an individual from the egg is the most marvelous phenomenon in Nature. The evolution of organic forms through eons of time pales beside what we can witness daily, superficially at least, in the development of the individual from the egg.



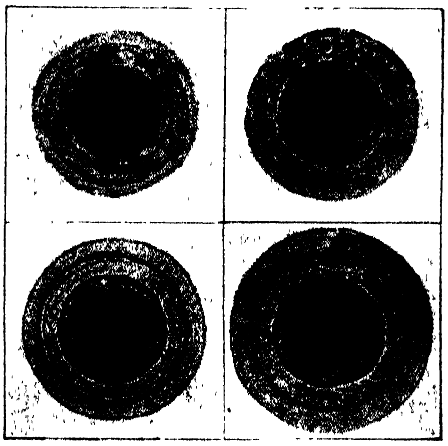
EGGS OF MOUSE AND DOG

The mouse egg (left) is rather transparent, while the egg of the dog is opaque



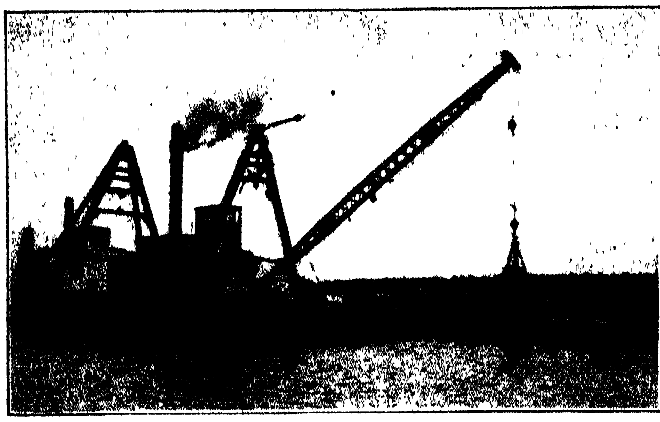
CLOSE-UP OF OPOSSUM EGG

All of the pictures on this page are photomicrographs of actual living eggs



DIVIDING RABBIT'S EGGS

These have been fertilized and are developing. Note one, two, three, and four-celled stages of cellular development



THE "JUPITER"

The floating dredge which excavated the half mile long river-bottom trench for the tunnel sections, which were sunk in place

THE "NONE-SUCH"

Specially designed craft from which a steel grillage was dragged to level off the sand and gravel bed of the trench for the tubes

Detroit Digs Under to Canada

Vehicular Tunnel Under Detroit River, Soon to be Completed, Will be Important International Highway Connection

By HARVEY KLEMMER

A PRODIGIOUS step in Man's never-ending conquest of natural barriers is being taken at Detroit, where engineers are constructing the world's first international vehicular tunnel between that city and the Canadian municipalities across the river. It is particularly fitting that Detroit, the automobile capital of the world, thus should blaze a new trail for the automobile. Crossing the Detroit River always has been a tedious ferry process; the Detroit and Canada tunnel will bring the downtown districts of Detroit and Windsor, Ontario—the Canadian terminus—within three minutes of each other, supplying at the same time a transportation link of importance to all of Michigan and the Ontario Peninsula.

The tunnel has been under construction for the past two years, with the official opening scheduled for this summer. The tube is approximately one mile long, will cost 25,000,000 dollars, and terminates in the heart of the business district at each end. The traffic capacity will be 1000 vehicles per hour in each direction.

This is the third sub-aqueous roadway to be constructed in the United States, and the first to be constructed internationally. The other two vehicular tunnels in the United States are the Holland Tunnel connecting New York City with Jersey City, and the George A. Posey Tunnel under the estuary at Alameda, California.

Construction of the new tunnel is being accomplished by three separate and distinct methods. Some of the engineering processes are similar to those employed on previously-constructed tunnels; others offer new and distinct departures from any methods of construction previously used on an undertaking of this kind.

The work has been divided into five sections in accordance with the methods of construction. The five sections in turn fall into three general classifications. Sections 1 and 5 are the usual box type of subway, with steel bents and concrete jack arches, and are being constructed by the "open cut method." This method of construction is being used on both of these sections up to a depth of 53 feet below street level. Sections 2 and 4 are being constructed by the "tunneling shield method" and extend from the open-cut operation approximately to the harbor line at each end of the tube. Section 3—the river operation—is being constructed by the "trench and tremie method," embodying the sinking of previously-constructed tubes in a trench dug across the bottom of the river.

BY far the most spectacular of all the tunnel operations is the construction of section 3. This is composed of nine steel tubes, all built on dry land, launched like ships, floated into position, and then sunk merely through the weight of interior and exterior concrete. Several engineering departures are involved.

Most land-built tunnel sections heretofore have been sunk through the addition of water or sand to the interior. If they were concreted, that operation generally was performed after the tube was in its river-bottom resting place. Tubes for the Detroit River tunnel, on the other hand, were fully concreted inside and out while on the surface and then sunk without admission of any foreign material to the interior. So accurately was the weight of the concrete computed that each tube thus far has been made to sink practically of its own weight, the addition of a few concrete blocks being sufficient ballast in each case.

The tubes, varying in length from 220 to 248 feet with an over-all diameter of 35 feet, were constructed on a launching way at the plant of the Canadian Bridge Company at Ojibway, Ontario.

As each segment was completed, it was fitted with heavy, water-tight bulkheads and sent down the ways. The interior and some of the exterior concrete then was applied, and the tube was ready for its five-mile journey to Detroit.

Each tube when launched weighed about 500 tons. When partially concreted for towing upstream, its weight had increased to some 4000 tons. When fully concreted the tube became an 8000-ton monster of steel and concrete.

The final concreting was accomplished at an anchorage constructed in the river several hundred feet from shore. As the tube gradually sank beneath the river surface, a large buoyancy scow was placed over each end and the tube suspended from lines attached to winches aboard the scows. The whole outfit then was moved into position over the previously-excavated trench and, moored to anchorages in all directions, the tube was gently lowered into place. Specially-designed flanges permitted locking of the tubes together under water by the three divers kept constantly on the job.

Exact alignment of the tubes was accomplished through the use of tall masts attached to each tube as sunk. When the tube came to rest on its bed of sand and gravel, the tips of the alignment masts were used for exceptionally accurate lining-up. The nine tunnel tubes must be projected across the river bottom to meet the Canadian shield-driven section with an error of less than one inch!

THE irregular bottom left in the trench by the dredging operation was smoothed over by means of a special contrivance designed for the tunnel job. This strange craft, christened the *None Such* by the men, consisted of a huge pontoon arrangement supporting a carriage on tracks. From the carriage was suspended a steel grillage approximately the width of the trench. Sand and gravel were poured into the trench and leveled off by dragging the grillage back and forth over the area to be prepared.

The tunnel shield used for the excavation of sections 2 and 4 is the largest in North America and when designed, was the second largest ever built. The Holland Tunnel, which consists of two tubes, each smaller in diameter than the Detroit tunnel, required smaller shields. The shield has an outside diameter of 32 feet 3 inches, and is 15 feet long. The outside diameter of the steel tunnel lining measures 31 feet 8 inches. The inside diameter throughout will be 28 feet. A 22-foot roadway will allow one lane of traffic in each direction, with an extra lane for emergency purposes.

Photographs courtesy Goodwin, Inc.

SANDHOGS USING POWER KNIVES

Note consistency of clay, a slice of which is held by one of the men. The knife is a cable-pulled sharp ring

Progression of the shield-driven section of the tunnel resembles the operations of a giant mole. A gang of workmen known as "muckers," or "sandhogs," digs ahead of the shield, slicing away the earth with power-operated knives. When they have excavated a few feet in advance of the equipment, the shield is forced ahead 30 inches to occupy the space thus won. This is known as the "shove."

Thirty hydraulic jacks, each capable of exerting a pressure of 150 tons, push the shield ahead. The jacks are operated with water from the city mains, forced into an accumulator at pressures up to 6000 pounds per square inch, and fed to the jacks at constant pressure.

After each shove, a hydraulically-operated erector arm picks up segments of lining and swings them into position. When a complete "ring," 30 inches wide, has been placed, the muckers have again advanced and the shield is ready for another shove.

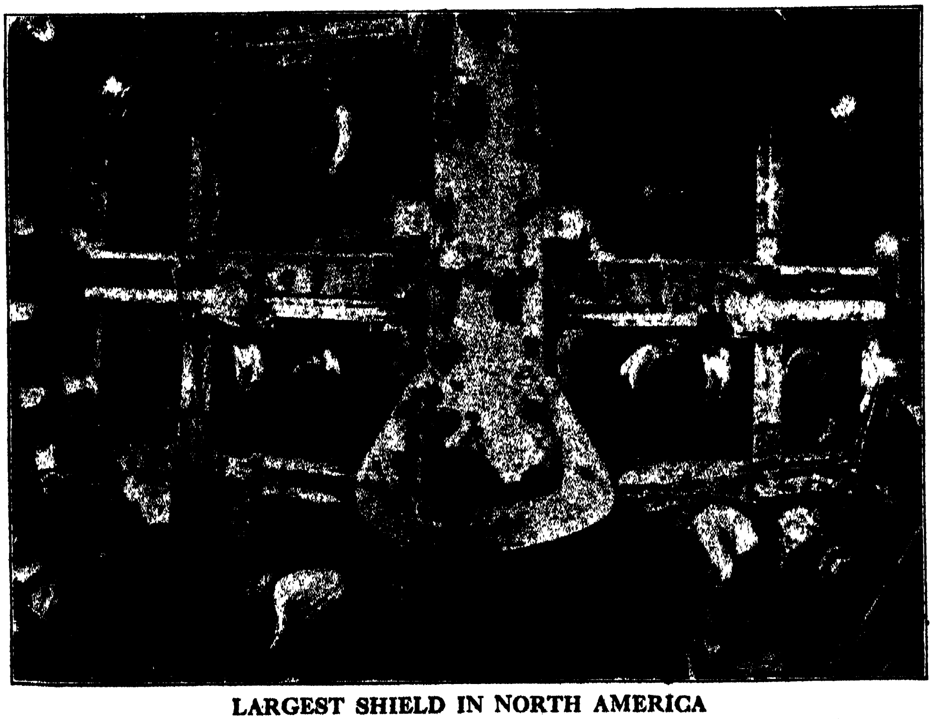
Another innovation of the Detroit tunnel job is the use of steel lining for the shield-driven section. Heretofore cast iron or wooden lining has been used. In this tunnel the lining is made of stamped, electrically-welded steel plates. The steel plates, surprisingly enough, represent an actual economy as well as a structural improvement over the older forms. The weight of the steel lining is about 2.3 tons per lineal foot of tunnel, while the same unit in cast iron would weigh about eight tons per lineal foot.

Each segment of lining is 30 inches wide, 10 inches deep, and nine feet long, weighing approximately 1000 pounds. Eleven segments and a key comprise a complete ring of lining. As the shield progresses, the segments are erected and bolted in place, the joints between each segment and between successive rings being waterproofed.

A TOTAL of 466 feet was excavated at the American end of the tunnel by this method, after which the shield was knocked down, hoisted to the surface, and transferred across the river. About 1243 feet are to be excavated in this fashion on the Canadian side. As this is written several hundred feet have been completed and the shield is making progress of 12.6 feet a working day. The Canadian shield is expected to reach the harbor line early in the spring, in time to join the last tube when it comes up the river from Ojibway.

As soon as the shield is removed, interior concreting is begun. Steel forms running on tracks are used in pouring the concrete. The whole structure of forms is run forward 25 feet at a time, concreted, then pushed ahead for another lap.

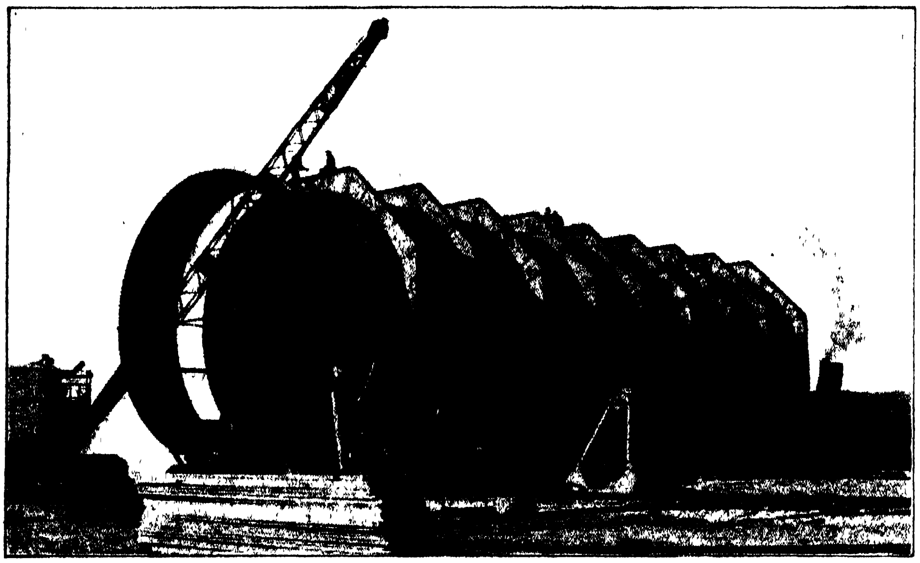
Sections 1 and 5—the box-type subways—offer no unusual features of construction or design. Steel sheet piling is driven on each side of the open cut and the material taken out with subway shovels and clam buckets. The shoring follows immediately behind the excavation. A three-inch slab of concrete is poured at the invert, upon which four-ply membrane waterproof-



LARGEST SHIELD IN NORTH AMERICA

The muckers work in front of this huge apparatus, digging out the clay with power knives and passing it back through the shield to others who remove it to the dump. Note great size ing is placed. The structural steel frame is erected, the invert, side walls, air ducts, and roof are concreted and backfilled, and the street surface restored. Connecting the portal of the box section and the terminals at each end is a short stretch of open approach, reinforced concrete invert, and concrete retaining walls.

Spacious terminals have been provided at each end of the tunnel, the American terminal plaza being two acres in extent. Traffic at the American end will spiral in coming to the surface, while the Canadian roadway, being farther back from the river, comes to surface level in a straight line.



BUILT LIKE A SHIP

A partially completed tunnel tube on the launching way at the plant at Ojibway, Canada. These tubes were fully concreted inside and out before final sinking to the bottom of the river

Ventilation of the tunnel will follow closely the design worked out for the Holland Tunnel and found extremely successful in practice. There will be two ventilation towers, one at each end of the tube. The equipment for each tower consists of 12 motor-driven fans, six for fresh air and six for exhaust, arranged in successive tiers in different stories and with direct connections to the subway ducts.

THE amount of fresh air that can be pumped into the tunnel will be 1,500,000 cubic feet a minute, giving a complete change of air in the longitudinal ducts every 90 seconds. The fresh air will go into the roadway through curved apertures near the curb line; the vitiated air will be drawn off through two rows of openings located at frequent intervals in the ceiling.

The air in the tunnel, according to the engineers, will be purer than the air in the street outside during rush hours. The power layout is so arranged that any part of the equipment can be operated from either the American or the Canadian side.

Many interesting articles have been brought to light in the various excavations of the Detroit and Canada Tunnel, the engineers report. One of the most interesting is an old Indian sling, with a cord of bark fiber still attached. Other finds include several firearms, a goodly number of bottles of beer and liquor, the remains of two small boats, automobile parts, and three human bodies.

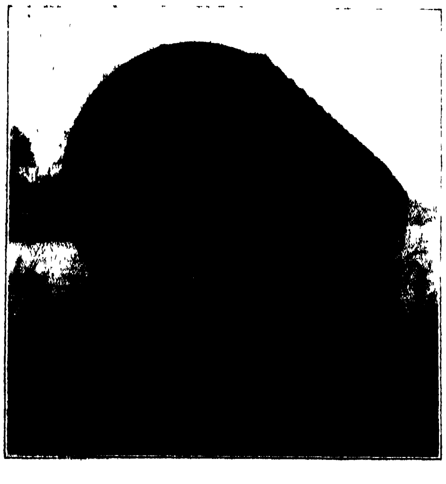
Two of the bodies were found by the river crew engaged in sinking the tunnel tubes; the other was brought up by the dredge *Jupiter* in a clamful of mud. The *Jupiter* also brought up the liquor, the firearms, the boat remains, and the Indian relic. The automobile parts were encountered by the shield in its excavation at the American end of the tube.

The terminal gang also made a find. Their contribution to the tunnel museum was a goodly amount of old wooden water pipe, placed beneath the streets of Detroit almost a century ago and still in good shape when unearthed.

THE tunnel will be operated jointly by the Detroit and Canada Tunnel Company and a Canadian subsidiary. Policing, regulation of traffic, and enforcement of customs and immigration regulations will be undertaken by the American and Canadian governments, officers of each nation looking after that portion of the tube lying within their domain. Completion of the tunnel is expected to result in an international interchange of visitors such as rarely, if ever, seen anywhere in the world, according to Judson Bradway, president of the tunnel company.

Figures compiled by the Border Cities Chamber of Commerce show that 25,000,000 persons are crossing the river annually at Detroit now. As many as 70,000 automobile passengers have been carried by the ferries over a single week-end, without taking into account the many casual visitors who cross on the ferries without cars for business and pleasure.

Because of the 15,000 commuters who make the daily crossing; because of the 3,000,000 tourists who cross each summer, many bound across country and more headed for the Canadian wonderlands in Quebec and the Georgian Bay country; because of the large number of shoppers and casual visitors; and because of the growing popularity of the Canadian resorts around Lake Erie and Lake St. Clair—because of all these things the Detroit and Canada tunnel is being rushed to completion with a future of singular promise.

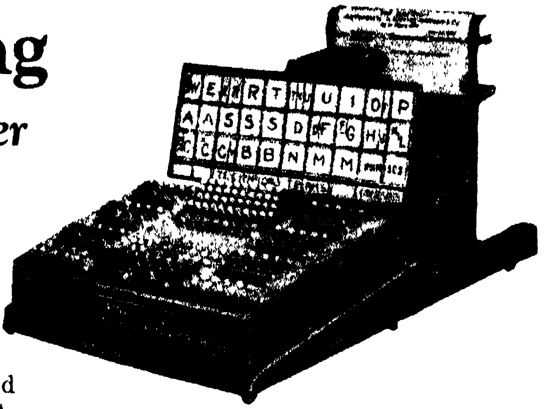


LAUNCHED LIKE A SHIP

Two views of a launched tube just after leaving the ways. With ends bulkheaded, tubes were towed to the floating concreting plant, concreted, and then sunk to the bottom

Automatic Word Writing

Departures From Familiar Typewriter Found in Word Writing Machine



WORD WRITING MACHINE

Although less than twice the size of a common typewriter, this machine does the work of many

MODERN business, in its restless search for the ultimate in operating efficiency, is always finding new short-cuts. Of these, an interesting one is a recently patented word and phrase writing machine for use in offices. Although it includes many of the essential features of the typewriter, this device differs radically from equipment now in use.

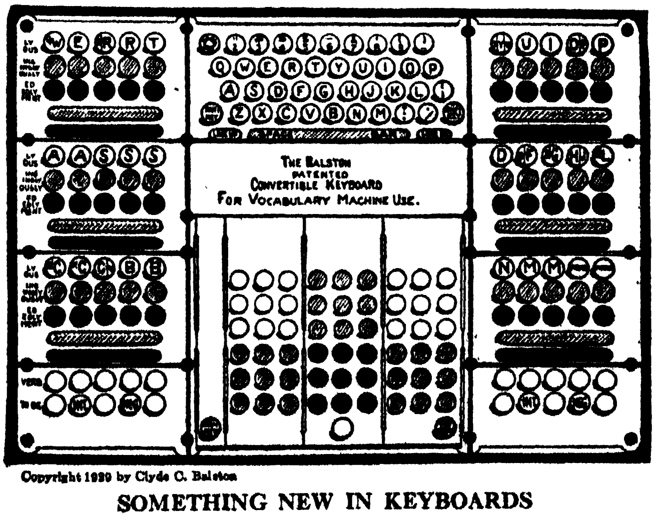
Mr. Clyde C. Balston, the inventor, based his research on the conclusion that there is no justification for the present "unit method" of typewriting. He challenged the prevalent conception that every word written mechanically must be first decomposed into its individual letters and then re-assembled as words on the paper. He decided that it should be possible to perfect a machine which would collect and print the letters of a word automatically, without requiring a separate movement to produce every letter and space. This led to the conclusion that there are a number of common phrases which are used innumerable times each day in office correspondence, which might just as well be impressed on the paper as if the phrase were one word.

Before working out the mechanical details of the machine, Mr. Balston spent some years on an exhaustive study of words to determine the relative frequency of their use. It was found that about 100 words comprise more than 50 percent of all words used in business. Less than 400 words represent more than 90 percent of those we use and about 1000 words constitute slightly more than 98 percent of all business correspondence. For these words, stenographers use "word signs" or symbols, rather than attempting to record the individual letters of each word.

In operating the word and phrase writing machine, there is no need for the typist to use the usual lightning-like movements, because the world's fastest typist cannot compete with a machine that prints a whole word or phrase while a typist using the unit system would be writing the first two letters. With much more deliberation, the operator presses two keys, one representing the initial letter of the word or phrase to be written and the other a selector. The use of the keys is guided by a chart which shows the grouping of the words, and the relative position of the selector keys. As with the "standard" keyboard, the operator may become so familiar with the position of the keys that no time is lost hunting for the right one.

THE machine automatically assembles the letters and impresses the word or phrase on the paper, with the requisite spacing and punctuation. The type is mounted on an assembly of revolving disks somewhat reminiscent of the mileage recorder of a speedometer. A series of interchangeable combs with movable teeth, operated by the selector keys in accordance with the chart, automatically catch the various disks and hold them in the proper position for impressing the word chosen by the operator. As soon as the word is impressed, the disks are released and spring back into a neutral position ready for the next word.

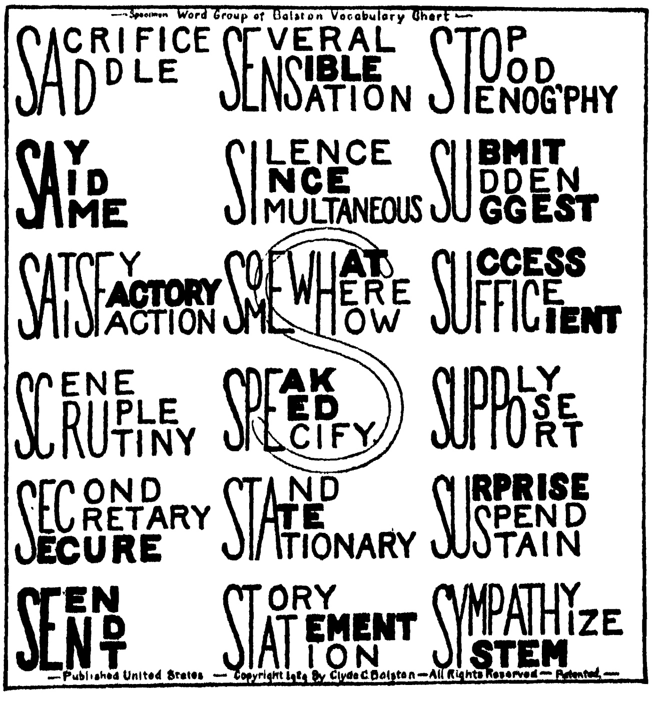
The mechanical writing speed of the machine, according to Mr. Balston, is more than 1000 words per minute, and the operative writing speed is over 300 words per minute, when writing single words. When writing phrases, the number of words per minute is greatly increased. It is significant that the Balston machine retains the standard typewriter keyboard, in addition to the special keyboard governing common words, word-endings, place-names and phrases. The more familiar keyboard provides an efficient means of writing (by the unit system) words seldom used, variously spelled proper names, and other words or phrases infrequently used in business correspondence. The machine has been adapted for use by telephone companies in posting and billing toll charges.

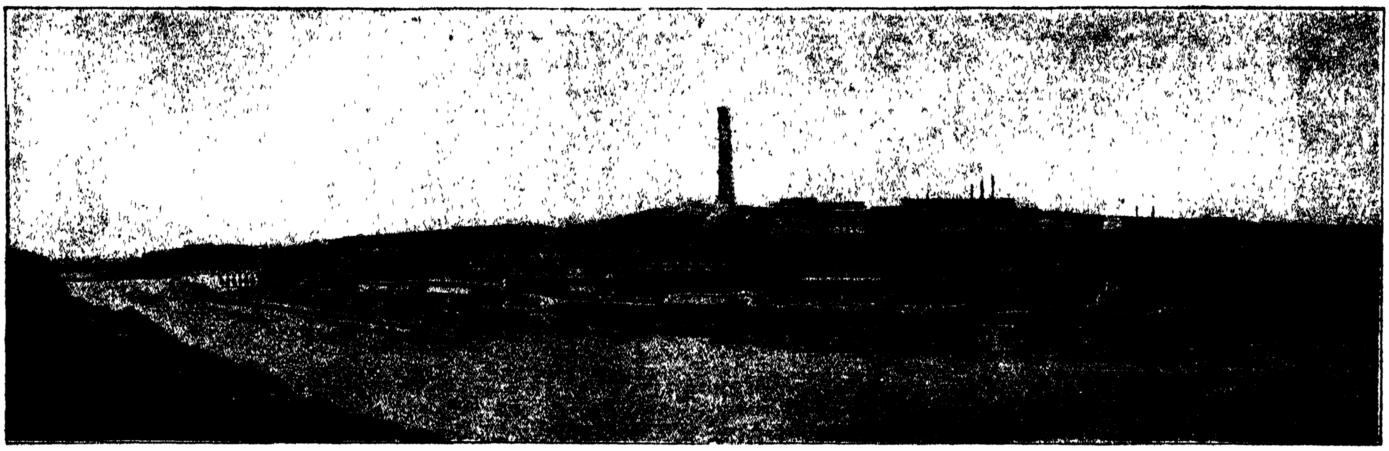

The Balston Patented Convertible Keyboard For Vocabulary Machine Use.

Copyright 1930 by Clyde C. Balston

SOMETHING NEW IN KEYBOARDS

Above: Keyboard of the Balston machine, showing arrangement and grouping of keys. Note the standard typewriter keyboard, which has been retained for writing variously spelled words and names. The three 18-key panels are operated according to the groupings of words on a chart mounted within view of the operator of the machine. *Right:* Specimen square of the chart, showing alphabetic arrangement of words used most commonly in business correspondence. Capitalization and terminal forms may be included





GREAT FALLS REDUCTION DEPARTMENT OF THE ANACONDA COPPER MINING COMPANY

Situated on the upper Missouri River in Montana, in the heart of one of America's great hydro-electric developments, the Great Falls Reduction Department includes the largest electrolytic zinc plant in the world, an electrolytic copper refinery, and a copper rod and wire mill

Refining Metals by Electrolysis

Production of Refined Zinc and Copper by the Electrolytic Process in the World's Largest Metal Reduction Plant

By HENRY W. HOUGH

"WHITE COAL" was responsible for the selection of the site for the Anaconda Copper Mining Company's electrolytic zinc reduction plant near Great Falls, Montana. The importance of an ample supply of cheap electric power is easily understood, for the plant sometimes demands as much as 64,000 kilowatts, or 85,000 horsepower. The total connected motor load of the 600 alternating- and 182 direct-current motors in service, including the rotary converters and motor-generators, is 102,000 horsepower. In addition to the zinc plant, which is the largest of its kind in the world, the properties include also a large electrolytic copper refinery and a mill for making copper rod and wire.

TRANSMISSION lines carrying 110,000 volts transport power from the hydro-electric stations of the Montana Power Company at the Great falls and the Rainbow falls, in the upper Missouri River, supplemented by four 6600-volt transmission lines from the Black Eagle falls station adjacent to the plant. A fourth large hydro-electric plant is now being constructed in the vicinity, at Morony Dam. The most distant of these power sources, at the Great falls, is only seven miles from the plant.

Although the mining region centering at Butte, Montana, has been famous for 25 years as the greatest copper producer of the world, it had its inception as a placer gold mining camp, when gold was discovered in the sands of Silver Bow Creek in 1864. Silver soon became the most sought-for mineral, for valuable silver ores were found in the oxidized parts of quartz veins prominently traceable on the hillsides. The claims staked on these lodes later proved to be enormous producers of copper, as the diggings were carried farther beneath the surface. In 1887 about 290 stamp mills were working the silver ores of the Butte district, but the industry reacted sharply to the sudden drop of silver prices in 1902.

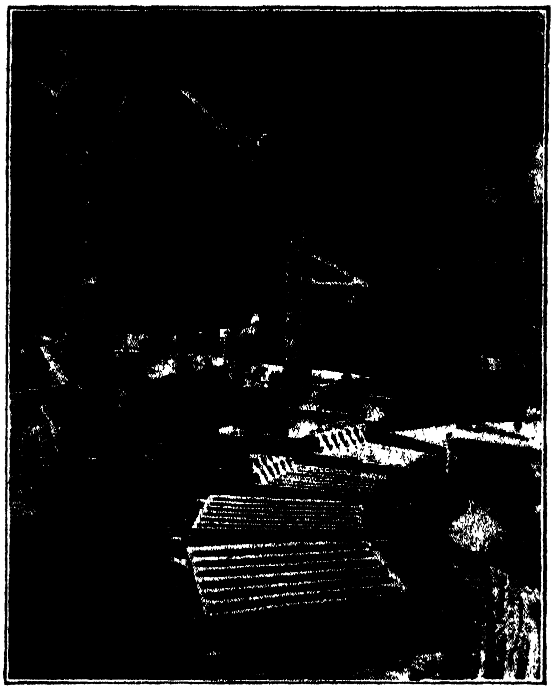
However, the copper industry had already reached its full stride. From 1870 to 1879 claims had been staked covering most of the valuable copper deposits, although many of them, like the Anaconda claims, were located for silver ore. The copper ore was originally hauled to Corrine, Utah, on the Union Pacific Railroad. After this 400-mile haul, it was transported to eastern plants for treatment. Some of the chalcocite was shipped to Swansea, in Wales.

IN 1879 the first successful smelter in Butte was built by the Colorado Smelting Company, greatly stimulating the local production. Several other smelters were constructed within a short time, including the Parrot, Montana Copper, Bell, and Clark's Colusa. The Montana Copper Company established its smelter at Great Falls, 180 miles from Butte, in 1892, under the name Boston and Montana Consolidated Copper and Silver Mining Company. The smelter at Anaconda, about 15 miles from Butte, was started by the Anaconda Copper Mining Company in 1883. In 1902 the "new works" was built across the valley. This plant, the largest non-ferrous smelter in the world, treats about one fourth of all the copper produced in the United States.

Our Basic Industries

DESPITE rumors of business recession as a result of the sharp decline in stock valuations, the foundations of our prosperity are secure. Almost without exception, our basic industries are in sound condition. This fact is discernable in the mining and allied industries. According to the Copper and Brass Research Association, the copper industry is on a firmer foundation than at any time in its history. It has just passed through a year of unparalleled peace-time prosperity. The outlook for the year 1930 is described as "most encouraging." Much of this optimism is due to the increasing demand at home and abroad for copper to be used in railway electrification, transmission lines, power projects, building, and automobile manufacturing.

In accordance with our policy of keeping our readers well informed concerning significant developments in industry, we sent one of our editors to Montana to inspect the world's largest plant for separating and refining metals by the electrolytic process. By previous training and experience, Mr. Hough is well qualified to describe these properties, and the interesting process of refining by electrolysis.—*The Editor.*



CASTING COPPER WIRE BARS

Streams of molten copper flow into forms that are pivoted upon a casting wheel 40 feet in diameter

Its 585-foot smokestack is the highest in the world; the Washington Monument could be placed inside of it, and would be completely out of sight.

At Great Falls, the Boston and Montana Company had erected a plant for the production of blister copper, a blast furnace plant for the re-treatment of converter slag, a furnace refinery, and an electrolytic copper refinery. In 1910 the properties of this firm were taken over by the Anaconda Copper Mining Company, and six years later the first electrolytic zinc reduction plant was erected, after years of costly research and experimentation. The present plant produces about 20 percent of the world's total output of zinc. It has a capacity of 335 tons a day, or about 20,000,000 pounds a month, of practically pure zinc.

METALLURGICAL science wrestled for years to perfect the electrolytic zinc process. No one seems to know who first thought of leaching roasted zinc concentrates with dilute sulfuric acid and recovering the zinc as metal from solutions by electrolysis; it had been tried as early as 1883, but the most nearly successful early attempt was made in 1898 at a plant in Australia, erected to treat Broken Hill ores. Aided by the development of the selective floatation process for the preliminary preparation of the ore, and stimulated by high war-time prices for zinc, metallurgists of the Anaconda company developed the process which led to the construction of the plant at Great Falls in 1916. The company has another electrolytic zinc plant in Anaconda. These two Montana plants have a combined output of approximately one million pounds of zinc a day. Other plants of a similar nature, owned by the Anaconda Copper Mining Company, are located in Idaho, Utah, Australia, Poland, Italy, and Germany. New plants are being built in Illinois, Canada, and Norway.

Floatation concentrates arrive at the Great Falls zinc plant in open-top, hopper-bottom, 50-ton steel cars. After control and umpire samples are taken of the contents of each car, for use in deciding its composition and value, the concentrates are dumped into storage bins. There are 19 of these bins with a total capacity of about 3300 tons. Concentrates of varying composition are blended to give a uniform feed for the roasters.

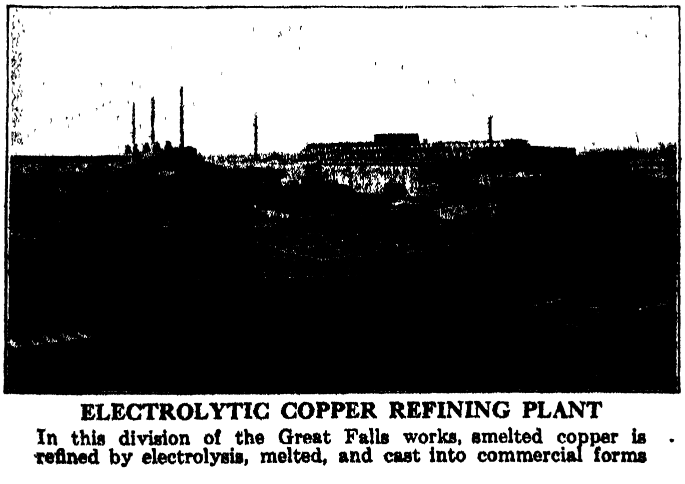
To convert the zinc concentrates into a product suitable for treatment in the leaching plant, the material is roasted. This process converts the zinc and lead sulfides into the sulfate and oxide forms, expelling the excess sulfur and oxidizing the iron and other metals in the ore. Each of the 14 roasting furnaces has an individual motor for driving a revolving center shaft which is five feet in diameter, brick lined, hollow, and equipped with 26 water-cooled arms. These arms have rabbles for moving the concentrates from the circumference to the center of the furnace, and vice versa. The furnaces are each 25 feet in diameter, consisting of a brick-lined shell with seven hearths inside and an open hearth on top.

THE furnace gases pass through a settling chamber before going to the "big stack," which is almost as tall as the one at Anaconda. The dust recovered is returned to the roasters; the total flue dust re-treated averages a little over 15 percent of the weight of the new material treated. Calcine, the product of the roasters, is drawn off in hoppers under the furnaces, transported in four-ton cars to revolving coolers, and then discharged into a 400-ton storage bin for shipment by the local electric train to the zinc leaching plant.

Natural gas is used for firing the furnaces. Each one has two burners which are fired directly into the seventh hearth, eliminating the use of fireboxes. As much as eight million cubic feet of natural gas is used daily in the Great Falls reduction works. The gas is piped from the Kevin-Sunburst oil field, about 100 miles northwest of Great Falls.

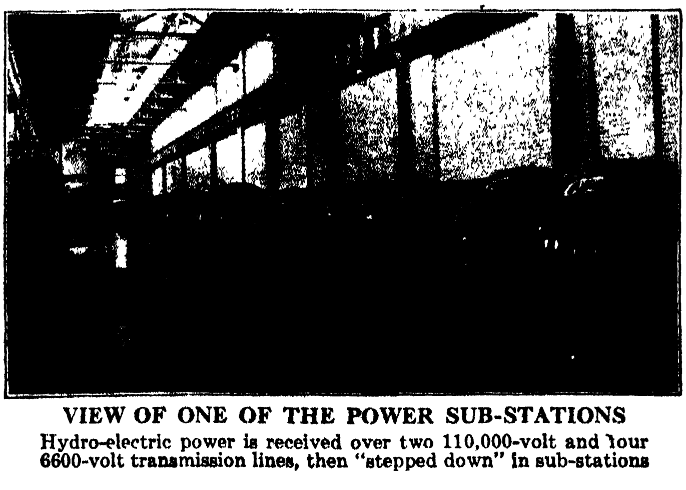
In view of the fact that the furnaces have also been fired with pulverized coal and fuel oil, some interesting comparisons are available. Using pulverized coal of about 9500 B.T.U., it requires about one seventh of a ton of coal for roasting one ton of concentrates. About 14 gallons of fuel oil, with 18,500 B.T.U., and specific gravity of 0.92, is needed for one ton of concentrates. About 2400 cubic feet of natural gas, of 930 B.T.U., is adequate for roasting the same amount of material.

There are three principal steps in the zinc leaching process: first is a neutral or purification leach; second, the acid or finishing leach, and finally a retreatment of the residue from the acid leach. In huge open tanks of the Pachuca type, the roasted concentrates mix with an acid solution used previously in the electrolytic tanks.



ELECTROLYTIC COPPER REFINING PLANT

In this division of the Great Falls works, smelted copper is refined by electrolysis, melted, and cast into commercial forms



VIEW OF ONE OF THE POWER SUB-STATIONS

Hydro-electric power is received over two 110,000-volt and four 6600-volt transmission lines, then "stepped down" in sub-stations

CASTING REFINED ZINC INTO 50-POUND SLABS

After leaving the electrolyzing division, the thin sheets of zinc are melted. Skilled workmen dip long-handled ladles into the furnaces, and pour the hot, silvery liquid into moulds

The acid is neutralized in the process, and iron, arsenic, silica, alumina, et cetera, are precipitated.

After passing through a series of Pachuca tanks, the solution discharges into Dorr classifiers for removal of coarse material, and the overflow goes to thickeners for the separation of solids from the solution. The pulp is drawn from the bottom of the thickeners and again treated with the leaching solution in the tanks, after which the thickened pulp goes to Oliver filters. The filtrate is returned with the thickener overflow to the first leach, and the residue cake goes to dryers. After passing through the first set of Dorr thickeners, the overflow goes through a purification system which precipitates the copper and cadmium by agitation with zinc dust. After purification, the leached zinc-bearing solution is pumped into storage tanks, ready for the electrolytic treatment.

ACCORDING to Mr. Albert A. Wiggin, manager of the Montana Reduction Departments of the Anaconda company, "The successful electrolytic deposition of zinc from a sulfate solution is primarily dependent upon the purity of the solution fed into the cells." In the leaching and purification processes, no effort is spared to produce a solution entirely free of metals electro-negative to zinc.

Power enters the plant at 110,000 volts, and is stepped down through nine 6100-kilo-volt-ampere, three phase, 60-cycle, water-cooled transformers to 406 volts. This is passed through nine 5800-kilowatt synchronous rotary converters, which yield about 580 volts, direct current, for use in the electrolytic tanks or cells.

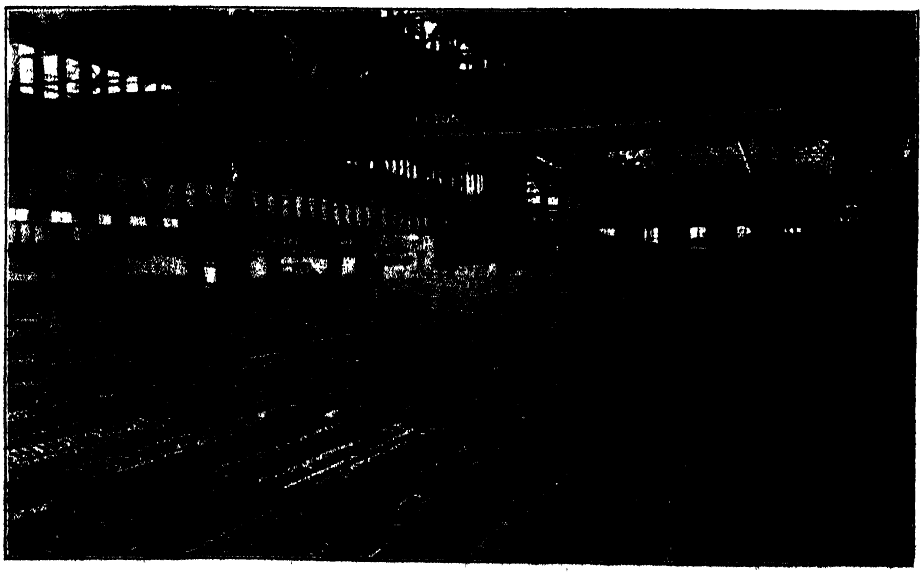
In a building 395 feet by 252 feet, zinc is electro-deposited on aluminum sheets suspended in tanks filled with the zinc-bearing solution. Of the 1164 cells, 1152 are continuously in service. These are divided into eight units of 144 cells each. Lead is used wherever there is danger of contaminating the solution, for lining the cells, and also as anodes from which the current flows to the aluminum cathodes. There is no free acid in the solution when it first enters the tanks, which are arranged in cascade form. When the electrolyte leaves the tanks (to be used for leaching roasted concentrates) it contains acid equivalent to one and one half times the amount of zinc removed during the electrolytic process. To cool the tanks, water is circulated through a lead pipe placed beneath the surface of the solution.

Every 24 hours the zinc-coated aluminum cathodes are removed, and the zinc is stripped off. These thin sheets of zinc are stacked in piles and moved on small cars to the melting and casting department. The sheets are dumped into the furnace through a hole in the roof, probably to be melted beneath the surface, for about 150 tons of molten zinc is kept in each of the three gas-fired furnaces. The molten zinc is dipped out of the furnace by means of long-handled ladles suspended from trolleys on overhead I-beams, and is cast into moulds arranged in rows near the furnace. One man can dip and cast into 50-pound slabs about 30 tons of zinc in an eight-hour shift. No practical scheme has been found for improving upon this laborious method of casting, although various mechanical arrangements have been tried.

Atomized zinc, or zinc dust, is made by transferring the molten metal to graphite crucibles tapped or perforated with one-eighth-inch holes. As the molten zinc falls from these openings it is caught in a jet of compressed air from an atomizing nozzle and is blown into a settling chamber. This product is used in the purification division for removing copper and cadmium from the zinc-bearing solution. Cadmium, by the way, has become an important by-product of the zinc plant, since this metal has come into use for electroplating.

ALTHOUGH the electrolytic zinc plant is the largest of its kind, it is but one of several divisions of the Great Falls Reduction Department. Copper refining operations are conducted on a large scale in an adjoining plant, where copper from the company's smelter at Anaconda is purified by electrolysis.

From 80 to 90 percent of the finished copper produced here goes to the nearby rod and wire mill. For many years all of the copper produced in the Montana mines went to eastern markets, much of it returning later in manufactured form at greatly increased prices. The establishment of the large wire mill at Great Falls has changed this situation, providing for the far west a convenient and economical source of supply.



VIEW IN ONE OF THE ELECTROLYTIC TANK ROOMS

This electrolyzing room is 585 feet long and 252 feet wide, and contains 1530 refining tanks, arranged in cascade form. The illustration shows also one of the seven traveling cranes

Diet Causes Fatigue

Working Efficiency Is Lowered by the Dieting Fad and Increased by Between-Meal Nibbling

FATIGUE, diet, and the working capacity of the modern business girl are closely related, and decrease in working capacity due to fatigue can be offset by the timely ingestion of highly concentrated, energizing foods, according to the findings of Dr. Thaddeus L. Bolton, head of the Department of Psychology, Temple University, Philadelphia, who has concluded a research investigation in which 20 feminine office workers were subjected to exhaustive tests of speed, endurance, mental alertness, and muscular control, at various hours of the business day.

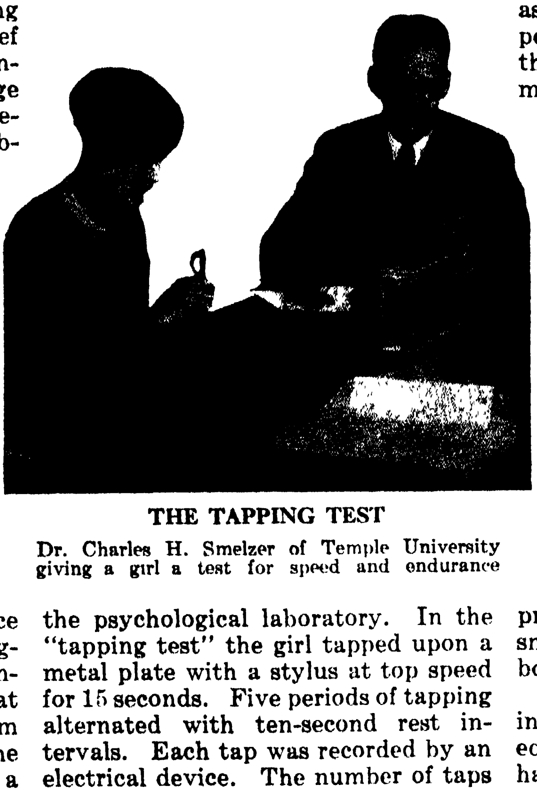
Back of the investigation, according to Dr. Bolton, lies the growing belief on the part of employers that the unwise reducing diets resorted to by large numbers of feminine workers are responsible not only for frequent absences due to illness, but for decreased volume and lowered quality of work while in the office. As the food suplies within the body approach the point of exhaustion, work power begins to fall, and fatigue sets in, starting up muscular trembling and lowering the speed and contractile power of the bodily members.

"OUR studies soon showed," Dr. Bolton says, "that working capacity is comparatively low at the beginning of the office day. The human machine is never, right from the start, ready to deliver its greatest output. Like the race horse, it must go through a warming-up process. Capacity appeared to increase until it reached its maximum at about 2:30 in the afternoon. From that time on, except for a spurt at the end, the curve seemed to fall with a fair degree of steadiness until the office closed in the evening.

"It is well known, however, that in the average office the hours between 2:30 and 5 are the period of greatest rush and strain. The falling curve occurs at the worst possible time. We sought to determine to what extent working power may be sustained at its early afternoon peak by eating suitable quantities of foods which are quick restorers of depleted energy. Foods having a high sugar content were selected because sugar is not only a concentrated energy food, but one which is quickly assimilated by the system. Its effects, therefore, are almost immediately apparent to the trained investigator equipped with the necessary laboratory instruments."

The 20 girls were divided into four groups of five each. One of the groups, the "full food group," was supplied each afternoon with a light meal consisting of cake, candy and sweetened orangeade. Two "mixed food groups" were supplied with the repast on designated days, skipping it on others. The fourth group, known as the "control group," went through the tests of the various elements which, taken together, constitute working capacity, without partaking of the additional meal.

Five different tests were employed, all of which have proved their value in the psychological laboratory. In the "tapping test" the girl tapped upon a metal plate with a stylus at top speed for 15 seconds. Five periods of tapping alternated with ten-second rest intervals. Each tap was recorded by an electrical device. The number of taps determined the score, which, in turn, afforded an accurate measure of the girl's speed and endurance. Both hands, one after the other, were tested.



THE TAPPING TEST

Dr. Charles H. Smelzer of Temple University giving a girl a test for speed and endurance

Co-ordinated muscular action was measured by the "three-hole test." This consisted of making electrical contacts by placing a stylus successively in three small holes in a metal plate, the holes being just large enough to permit the entrance of the stylus. The score made in the test was determined by the time it took to make 80 contacts. The "substitution test," employed to measure mental alertness, consisted of correctly placing five letters of the alphabet on a chart covered with rows of five different geometric figures. The key was given at the top of the chart. Two minutes were allowed for the completion of the test.

"All of the girls showed marked practice gains as they became familiar with the tests," Dr. Bolton says. "This had to be taken into account in compiling our results. Aside from practice gains, the 'control' or 'no food group' continued to show the typical curve of work—the low beginning, the rise until about 2:30, and the falling off until the closing spurt.

"In the case of the 'mixed food groups,' when the girls were supplied with the additional meal as frequently as four times a week, their work appears to have fallen in with that of the 'full food group.' Tabulated summaries of the tests given to members of the later groups show that they were sustained at a higher working rate than the girls in the 'control group.' Their practice gains were continued up to the last, and were greater and more consistent than the gains of the 'control group.'

"THE investigation has shown positive results in favor of small quantities of concentrated food taken in mid-afternoon. The physical and mental let-down which is apt to occur at the busiest period of the business day is to a considerable extent due to insufficient and improperly balanced diets, and can be largely, if not wholly, prevented by eating foods that in small volume act as quick fuel for the body engine.

"Although we dealt only with feminine workers, our findings apply with equal force to the opposite sex. Perhaps, however, special emphasis should be laid upon the support these findings give to the opinions of those who have held that reducing diets are responsible for impairing the efficiency of the modern business girl.

"On the basis of our findings, hard-working business and professional men and women would do well to keep in the drawer of the desk a box of good candy or candied fruit. When energy begins to flag in mid-afternoon, these quick-action foods will act as an emergency ration and supply the calories needed for the rest of the day's work. The sugar in afternoon tea, or in sweetened cold drinks, will have the same effect."

Approximately 500,000 calculations were necessary in compiling, tabulating, and comparing the records of the 20 girls.

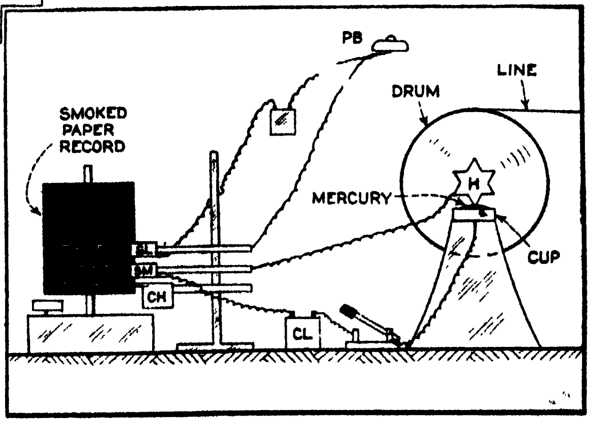
Swimming Speed Analyzed

"In the Breast Stroke We Can Develop the Same Speed as in the Crawl, But Only for a Fraction of a Second"

By PETER V. KARPOVICH, M.D., M.P.E.
Professor of Physiology, Springfield College, Massachusetts

WE watch a powerful swimmer plunge into the swimming pool and then rapidly traverse it using a crawl stroke. He moves so fast and his movements are so well timed that, to our eyes, his speed seems to be perfectly uniform.

We observe another man using a breast stroke. There we can notice that the swimmer is moving by spurts, slowing markedly on recovery, when he draws his arms and legs close to his body. Here we can figure easily the reason for the periodical accelerations and slowing of the speed.



THE NATOGRAPH

Above: The test subject, with the floating tripod and the line connected to the Natograph in the background. *Right: Figure 1:* The simple mechanism of the Natograph

But is the crawl stroke really a stroke where the speed is perfectly uniform? We know that there are several distinct phases in this stroke: lifting one hand out of water and rolling, breathing, pulling, et cetera. Do these changes in posture affect the speed or not? Logically they should, but can we find out definitely?

Swimming is an ancient and yet a young sport. People could swim in prehistoric times, but the present highly developed strokes are of recent origin. Some teachers of swimming are still searching for a new combination that will result in a stroke faster than the ones existing at the present time. Others are trying to improve the existing strokes. The latter effort seems to be more feasible and leads to an attempt to study the variation of speed within a single cycle of a stroke. Preliminary consideration showed at once that an ordinary stop watch could not be used because changes may occur within a second on a distance of a couple of feet.

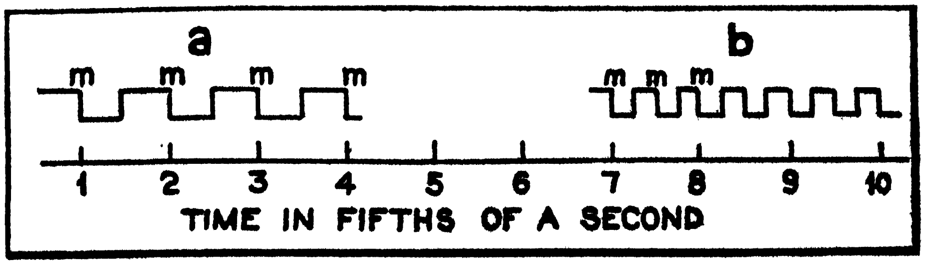
AS the result of a number of experiments, an apparatus has been devised for the purpose. This apparatus has been named the Natograph in order to distinguish it from the other machines used in research along similar lines. The Natograph registers the progression of the swimmer, by recording the distance covered and the time, and enables us to calculate variations of speed in intervals as small as one fifth of a second, and to measure the relative efficiency within a single cycle of a stroke.

The apparatus shown in the photograph and the diagram, Figure 1, consists of a drum around which a line is wound; the free end of the line is attached to the subject. In swimming, he pulls this line and causes the drum to revolve. A sprocket (*H*) is firmly fastened to the same shaft as the drum. On revolution the points of the sprocket touch the mercury in the cup. The mercury and the sprocket are in a circuit with a dry cell (*CL*) and a signal magnet (*SM*). When the sprocket touches the mercury, the circuit is closed and the pointer of the signal magnet is drawn down.

When the contact is broken, the pointer springs back. The circumference of the drum is twenty-four inches; therefore the distance between two points of the sprocket corresponds to four inches of the circumference of the drum. The movements of the pointer are recorded on smoked paper wound around a cylinder, which is set in uniform rotation by means of a clock work. A chronograph (*CH*) marks the time in intervals of fifths of a second. During an experiment we may get a set of tracings similar to the ones represented in Figure 2.

IN this diagram, the distance between any two adjacent "makes" (*m*) of the circuit corresponds to four inches of the distance covered by the swimmer, but we see that the intervals between the makes are not equal. In part *a* we count one interval in 1/5 of a second, whereas in part *b* we find two intervals. This means that the swimmer was moving with a variable speed, the fastest being at *b*.

In order to read these tracings more intelligently, another signal magnet (*SL*), Figure 1, was adjusted to the Natograph. This signal magnet was connected with a push button (*PB*) by means of flexible wires 12 yards long. The experimenter carries this push button in his hand and



NATOGRAPH TRACINGS

Figure 2: The time between the marking of the points *m* enables the operator to determine the speed of the swimmer. Parts *a* and *b* consist of records of different swimming speeds

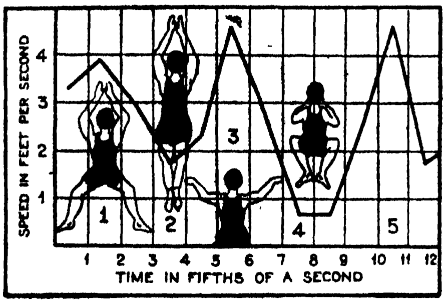
presses it when he wants to mark a certain part of the stroke. Suppose the experimenter wants to mark the moment when the right hand of the swimmer enters the water during a crawl stroke. He has only to press the button at this particular moment, and the writing point of the signal magnet (*SL*) goes down and marks the paper. See upper lines on tracings B, C, D, and E, Figure 3. Of course, particular care should be taken to have the writing points of both signal magnets on the same vertical line.

The construction of the Natograph is very simple, but one problem was at first very difficult to solve. This was the elimination of the momentum of the drum itself. Although the drum was made very light, it was necessary to use a brake which was strong enough to eliminate the momentum without interfering with the freedom of the progression of the swimmer. The resistance of the brake was negligible when compared with the total force developed during swimming.

FOR testing the breast and side strokes we attached the line directly around the waist of the swimmer, but for the other strokes, such as the crawl for example, it was impossible to do this because the feet might kick the string and spoil the record. To meet this difficulty a simple device was made. It consists of a wooden tripod, two legs of which are supported by rubber balls, and the third strapped to the swimmer. The line leading to the Natograph is attached to this tripod so that it always touches the surface of the water.

The Natogram in Figure 4 represents a record of the breast stroke as performed by a good Filipino swimmer. We can clearly see the variation of the speed in this type of swimming. The lowest speed (eight inches per second) was during recovery when the legs and the arms were drawn close to the body; during this time no propelling power was developed and the resistance was greatly increased. The highest speed was attained during the arm pull (five feet per second); during the leg drive the speed was four feet per second, and during the glide the speed dropped to one and one half feet per second. Comparing the action of the legs and the arms, we notice that the legs started to drive from the lowest speed after the recovery, and the arms from a higher level after the glide. This explains why great speed was often attained during the arm pull. If we introduce a correction, subtracting the starting speed from the speed reached at the end, we find that the leg drive is more effective than the arm pull, which is typical for a good swimmer. In the case of a poor swimmer, this condition may be reversed, whereupon the arms furnish most of the power.

The lower curve in Figure 5 represents a very slow crawl stroke. The "ups" of the curve correspond to the arm action. The low limit is determined by the momentum acquired and the leg action. The duration of a cycle is about one and two fifths seconds. The upper curve represents fast swimming by the same man. The curve is much smoother, and varies only between four and five feet per second. The length of a single cycle is about nine tenths of a second.

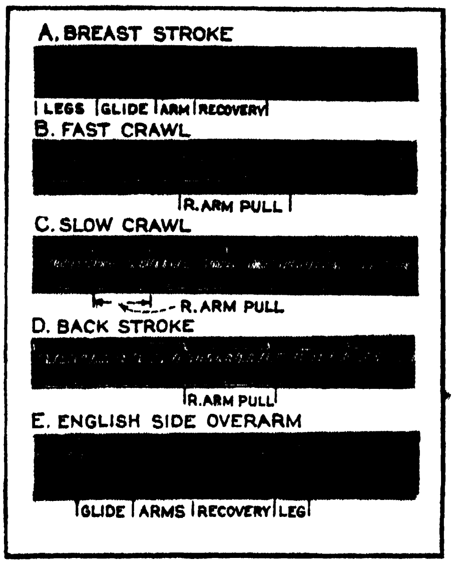


BREAST STROKE

Figure 4: This chart shows vividly how swimming speed with this stroke varies

We have found that the duration of the cycle in the fast crawl is shorter, and pull and recovery are reduced in the same proportion. The time during which both arms remain under water was only slightly decreased. The significance of this has yet to be investigated.

In Figure 6, the subject was swimming fast, using the back stroke. Because the arms cannot act as effectively as in a fast crawl, this curve resembles a slow type of crawl. Each elevation on the curve corresponds to the action of one arm.



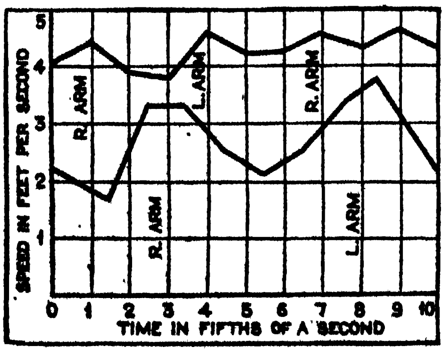
RECORDS

Figure 3: These are reproduced from actual tracings made on the Natograph

In Figure 7, made with the side stroke, we see the four distinct parts: the leg action, the glide, the arm pull, and the recovery.

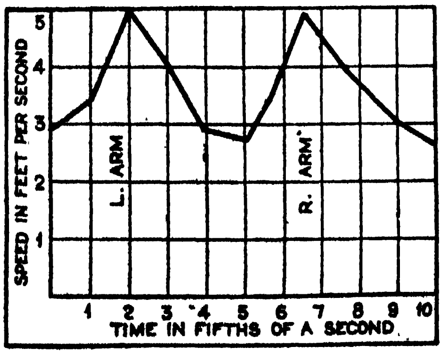
In this short article it is impossible to go into a discussion of all the points that may be discovered on the Natograph. Just recently I have completed the studies of the force developed during various phases of the different strokes and resistance of water that the swimmer has to overcome. The results of these studies perfectly correlate between themselves.

There is one interesting point that should be brought out. Driving a motor car with a variable speed is wasteful. A uniform speed is more economical. The same should be true in the case of the human machine. The crawl stroke is the fastest because it is the smoothest. In the breast stroke we can develop the same speed as in the crawl, but only for a fraction of a second and then on recovery the arms and legs serve as powerful brakes and hinder progress. In making a stroke more efficient, one should utilize the power saved by reducing the resistance.



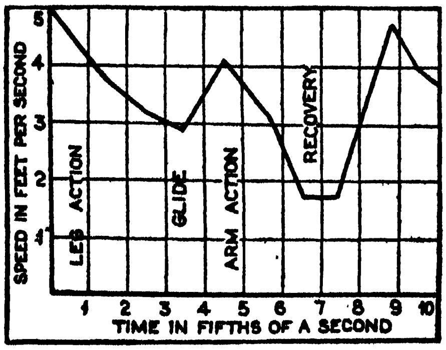
THE CRAWL

Figure 5: Lower curve shows slow crawl: upper, fast. Note the smoother action



BACK STROKE

Figure 6: Curve resembles that of slow crawl because of ineffective arm action



SIDE STROKE

Figure 7: Four distinct parts are shown; leg action, glide, arm pull, and recovery

The Plant's Whimsical Appetite

Some Newly Discovered Requirements for Plant Growth Indicate That Plants Are Highly Sensitive to Certain Chemicals

By EARL S. JOHNSTON
Associate Professor of Plant Physiology, University of Maryland, College Park, Maryland

IT is generally believed that plants can grow and develop normally when their diet is limited to the so-called ten essential elements. Most of these elements are found in the ordinary fertilizers used by farmers, gardeners, and other agriculturists. Everyone is familiar with the importance of nitrate, potash, phosphate, sulfate, and perhaps a few other plant food materials. In a somewhat similar manner carbohydrates, proteins, and fats were considered the essential part of the diet for animals, including man. Within recent years, however, it has been realized that man can not live by bread and meat alone. Articles are frequently published on the importance of vitamins. Occasionally, too, we read of the potency of hormones, those interesting chemical compounds manufactured by certain glands, which play such an important part in stimulating or retarding the growth of other tissue. The discovery of iodine in the thyroid was followed by the isolation of a stable iodine-containing hormone, *thyroxine.*

THIS simple example of the importance of iodine in the thyroid has brought into prominence the remarkable rôle that minute quantities of certain chemicals play in animal nutrition. Plant physiologists have been led to see the imperative need for a careful examination of the entire field of plant nutrition and to raise the question: Do plants also need minute quantities of certain less common elements for their normal growth and development?

Chemical analyses have shown that the list of elements found in plants is very long, but the mere presence of such substances does not mean that they are essential. How then can the really essential elements be distinguished from the non-essential? The logical biological test to determine the effect of a given element on plant growth is to grow the plant in soil to which this element has been added. Likewise, to determine the effect of the absence of such an element, the plant should be grown in a soil lacking that particular material. However, soil contains minute quantities of a large number of elements which it is quite impossible to remove or even detect chemically, and since it may be desirable to eliminate even a trace of certain elements in order to see how the plant responds to such a deficiency in its diet, soil cannot be used.

Briefly, the general method in common use is to grow the plants with their roots in pure water to which pure chemicals have been added. Thus a given element can be omitted quite easily. A good plant nutrient solution that contains the common fertilizer elements needed in comparatively large amounts, may be made up from the following salts expressed as volume-molecular concentrations (a method used to express concentration of solutions) and as percentage concentrations:

	vol-mol. conc.	*percent conc.*
$Ca(NO_3)_2$	0.005	0.082
$MgSO_4$	0.002	0.024
KH_2PO_4	0.002	0.027

In order to keep the plants green, about one cubic centimeter of a 0.5 percent ferric tartrate solution per liter of the nutrient solution should be added daily while the plants are young. The carbon dioxide of the air, and water, help supply the plant with oxygen, hydrogen, and carbon. By the use of distilled water, highly purified chemicals and carefully cleaned culture jars, it has been demonstrated successfully that in addition to the ten elements comprising the old list, we must now add manganese, zinc, boron, and perhaps several others. It must be remembered, however, that these elements are needed by plants in very, very small amounts.

HEALTH AND UNHEALTH

Figure 1: Tomato plants grown in nutrient solutions. Left, boron deficient; right, similar solution but containing one half part per million of the element boron

Boron is one of the elements that has been attracting considerable attention. It occurs in boric acid and in common borax, but its need in the plant was not even suspected until recently. In fact boron was considered a poison. Only a few pounds of borax per acre will work havoc to a potato crop. A disaster of this sort occurred a few years ago when certain fertilizers containing borax as an impurity were used. However, a very weak concentration of boron is not only beneficial, but absolutely necessary for the plant's health.

THE necessity of boron to the tomato plant was shown in an experiment in which two groups of plants were grown with their roots in nutrient solutions containing all the so-called essential ions. The solutions were similar with the exception of their boron content. No boron was added to the first group, while just enough boric acid was dissolved in the second to bring its boron concentration up to one part in 2,000,000 parts of water. Representative plants from the two groups are shown in Figure 1. The unhealthy condition of the plant on the left is clearly shown, especially when compared with the healthy one on the right.

Although the concentration of boron (1 part in 2,000,000) is extremely small, yet the plant has little difficulty in detecting it and in making good use of what it absorbs from the nutrient solution. Imagine how much a man would be nourished by eating pea soup in which there was one pea to every 132 gallons of water. That corresponds to the boron dilution which apparently suits the tomato plant. A concentration five times as strong, or in terms of our soup, five peas instead of one in 132 gallons of water, is distinctly injurious to the plant. Two to three parts of boron per million of water cause the margins of the leaves to die and soon the entire plant becomes unhealthy. On the other hand, the beneficial concentration of one part in 2,000,000 will frequently double the weight of the entire plant. The growth response when the proper amount of boron is absorbed by the plant is almost incredibly out of proportion to the small amount of the element involved.

The poisonous effect of too much boron is to be expected, but the surprising thing is that with no boron the plant is even worse off. The stem will not elongate because the terminal bud dies. The conducting tissues within the stem die. These tissues are composed of small tubes which carry the sugars made in the leaves down the stem. With the destruction of these tubes the plant's health is greatly impaired.

THE sugar manufactured in the leaves can not be transported to other parts of the plant where it is used for growth. Some of the sugar solution thus dammed up in the leaves is changed into starch, a storage form of carbohydrates. In the potato plant such leaves become thick and rolled, as illustrated in Figure 2. This condition closely resembles a disease called leaf-roll in which the conducting tubes are destroyed by disease and starch accumulates in the leaves instead of in the tubers.

Great care is necessary in performing experiments to demonstrate the injury caused by a lack of boron. One experimenter found that no boron-deficient injury was found when tap water was used in making up the nutrient solutions for tobacco plants, but if distilled water was used the plants failed to grow. The addition of a very small amount of boric acid solved the problem. There was enough boron in the tap water to supply the needs of his plants, but none in the distilled water until he added boric acid.

About Plant Fertilizers

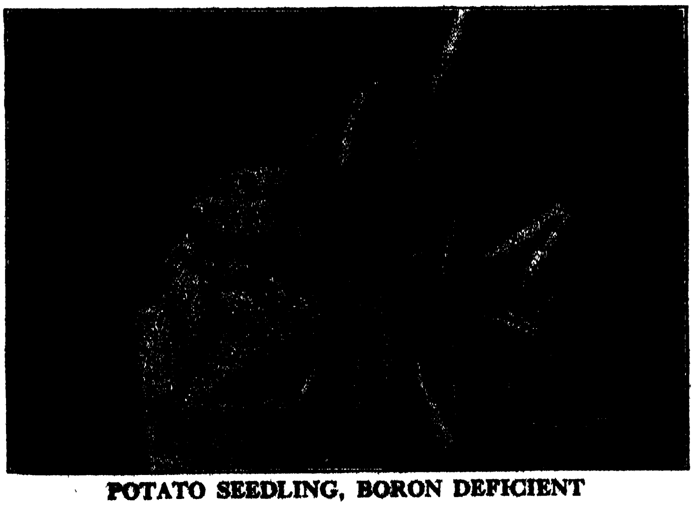
A PURE food and drug act for plants would be a death warrant to all living creatures. Few of us realize on what thin threads life hangs. Perhaps all of us know that in the ultimate analysis all animal life depends on plant life. Not until recently has it been known that many of our crop plants are absolutely dependent on minute traces of impurities or poisonous elements found in most soils and commercial fertilizers. In the light of such knowledge one may question the exclusive use of highly concentrated and purified fertilizers that are being marketed by certain companies.—*The Editor.*

The resourcefulness of the plant in getting its boron is well illustrated by the following incident. Several years ago an experiment was carried out in which potato plants were grown in new earthenware jars filled with pure quartz sand. These cultures were watered with a solution containing the elements previously found essential to plant growth. No boron was added, however. The first set of plants grew very well, but later, when these experiments were repeated, the plants failed to grow normally. After the importance of boron had been pointed out, it was realized that the plants in the first experiment had obtained enough boron from the glaze of the new jars to make good growth. The available supply of boron in the glaze had apparently been exhausted after the first experiment. This theory was put to a test by growing two sets of potato plants in the original jars, using the same general methods and similar solutions made up from the same lot of chemicals. Boron was added to the solutions used in watering one set of plants but not the other. At the end of eight weeks the difference in growth was very marked, as is shown in Figure 3.

PLANT containers of ordinary soft glass, such as the common Mason fruit jar, can very well be used in experiments dealing with boron deficiency. However, such jars may prove worthless when the effects of a zinc-deficient diet are to be studied. Zinc may be dissolved out of certain glasses which would make the results inaccurate in a manner similar to that in which the glazed jars had been used for boron-deficiency studies. In such work, jars made of the familiar Pyrex glass used in baking dishes serve the purpose very well, although they too, like glazed jars, are worthless for boron experiments. When such precautions are taken it has been clearly shown that zinc is just as much needed by a number of higher green plants as is nitrogen or potash, although of course in very much smaller quantities. It must be remembered that zinc, like copper and arsenic, is exceedingly poisonous.

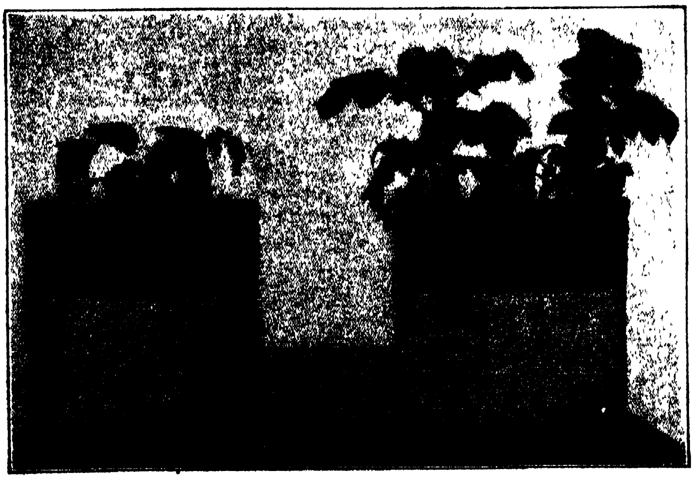
Thus it appears that there are a number of inorganic poisons which act as stimulants or as food to plants when given to them in small amounts. The concentrations of such substances vary with the poison as well as with the type of plant being treated.

With such examples in mind it is no wonder that earlier investigators on the nutritional requirements of plants failed to include some of these rarer ash elements in their list of essential elements. As methods became more and more refined and the chemicals purer, it was found that plants, like animals, demand minute quantities of certain substances which no one heretofore had even imagined to be important, much less absolutely necessary in the plant's diet.



POTATO SEEDLING, BORON DEFICIENT

Figure 2: The seedling was grown in a boron-deficient nutrient solution. The leaf roll characteristics are evident in the picture



A STRIKING CHECK TEST OF PLANT DIET

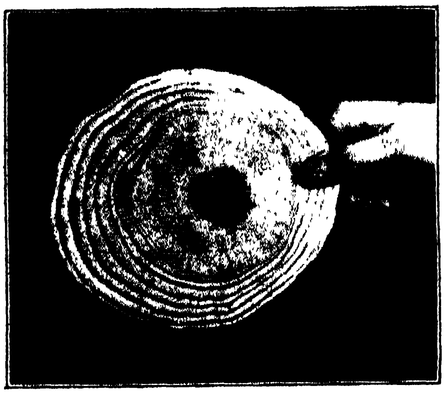
Figure 3: Potato plants grown in sand cultures treated with boron-deficient solution (left) and (right) with boron solution

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Bottle Drifts 7000 Miles

TWO unusually long bottle drifts have just been reported to the Washington Hydrographic Office. One bottle, thrown overboard by Officer O. Haugstad of the Norwegian steamer *Childar*, was picked up among the Marshall Islands after having drifted about 6000 miles. The second was found among the Caroline Islands after a drift of about 7000 miles. This bottle was one thrown overboard by Second Officer R. M. Stall of the American steamer *K. R. Kingsbury*.



Thin section of a "Pondosa" pine showing more rapid growth after mature and unhealthy growths were cut from around it. A tree puts on one or two rings each year

The longest drift in the records of the Hydrographic Office is one made from the southern Indian Ocean to the tip of Cape Horn between May 31, 1909, and May 19, 1912, a total of about 11,820 statute miles. —*Science Service.*

Rapid Lumber Growth Due to Selective Logging

IN the past SCIENTIFIC AMERICAN has commented frequently upon the necessity for conservation of our timber resources, for reforestation, and for the elimination of waste in logging operations. We have, therefore, urged selective logging as one of the best possible answers to this three-fold problem. When only the mature growth is cut for lumber and the unhealthy trees are weeded out, the remaining small, healthy trees are given a better chance to get the sun and light so necessary for their proper growth. The result is that these trees mature much more rapidly, young seedlings are given a chance to develop, and the forest may be cropped in exactly the same manner as a farm.

It is difficult for some people to realize how they may apply this principle in their wood lots. The writer has known farmers to cut ruthlessly all the trees of small forests for firewood or for lumber. To impress the truth upon such people, they have to be shown in a striking manner. Therefore we asked the Shevlin-Nixon Company of Bend, Oregon—whose policy of selective logging is well known—to send us facts to illustrate the benefits of the principle. They forwarded the thin section of a tree, a photograph of which is reproduced on this page.

The tree from which this section was cut grew very slowly for the first 80-odd years of its life, as shown by the compactness of the center growth rings. It was left standing when the mature and unhealthy trees all about it were logged. The result was that it grew in the last nine years of its life a greater volume of wood than it had during all its former life. It thrived on the sun and light that had been denied it while it was crowded by other larger trees in the immediate neighborhood.

"Tempered" Copper

"THE ancients" had hardened copper—tempered copper, as some believed—and so have we moderns. Indeed, we have had several varieties for many years. Nevertheless, persons yet talk of hardening of copper as a long lost art. Numerous uninformed inventors have sought to recover this art.

Dawson, a famous inventor of hardened copper, claimed to shave with a copper razor. He made surgical instruments, shears, and other edged tools of copper. We have a pair of shears, that after at least ten years will cut thin paper and other things demanding a keen edge. His copper was alloyed with 17 percent to 18 percent tin and ½ percent nickel. Through the influence of the nickel, Dawson's copper had a fine grain structure.

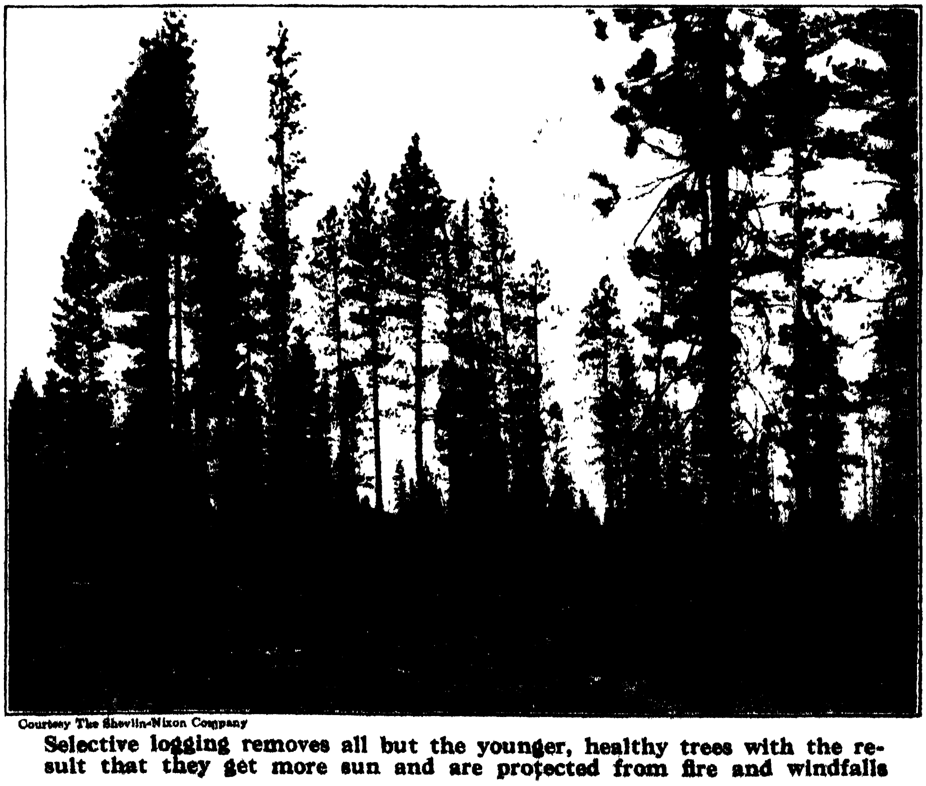
Erwin A. Sperry, a Connecticut metallurgist, proposed about 1905 an alloy of silicon and copper for springs. Plain silicon-copper alloy seemed difficult to handle and no one was successful with its fabrication.

Everdur and Tempaloy are two relatively new kinds of hardened copper. Both are alloys of copper with silicon and other metals and have approximately the physical properties of steel. Each was a by-product of research directed primarily toward another end.

During the World War, the du Pont Company was buying chemical plants in order to get their acid works. Some were in bad condition; quick repairs had to be made. Plain copper would not withstand the attack of certain chemicals being made or used in these plants. Tin was so scarce and costly that it could not be used for alloying the copper. Charles B. Jacobs, who was in charge, made castings from silicon copper to meet the situation. They were brittle and did not machine well.

Silicon was being produced in commercial quantities but was not being used for alloying copper. Silicon bronze had been known for a long time, but silicon bronze was tin bronze deoxided with silicon. Of course there was residual silicon in silicon bronze. That is to say: for thorough removal of oxygen a slight excess of silicon was used and a little remained in the alloy. Silicon, however, was not one of the main constituents.

Acid-resisting metals were much needed; researches were being made for alloys of desired qualities using metals that could be had in America. Reserch by Jacobs led to addition of manganese in various proportions to silicon-copper alloy. The alloy thus made worked satisfactorily and gave the required service. It had strength as well as acid-resisting qualities. It was patented and commercial manufacture undertaken. Everdur for castings contains 94.8 percent copper, 4 percent silicon, and 1.2 percent



Courtesy The Shevlin-Nixon Company

Selective logging removes all but the younger, healthy trees with the result that they get more sun and are protected from fire and windfalls

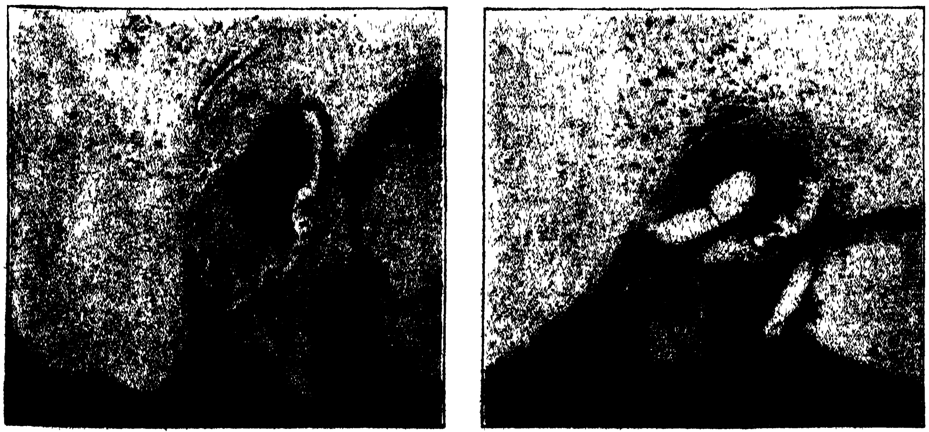
manganese. For wrought forms, such as rods, wire, sheets, and tubes, Everdur contains 96 percent copper, 3 percent silicon and 1 percent manganese.

Everdur made for casting can be forged and rolled hot, but will not stand much cold working. It hardens rapidly in both hot and cold working. Hence the need for an alloy that could be worked. Wrought Everdur is hardened by drawing or rolling, with marked increase of tensile strength and of hardness. Everdur resists corrosion by many kinds of acid and alkaline liquids. A great variety of uses are being found for this alloy.

Tempaloy is copper carrying nickel silicide. In other words, it is an alloy of copper, silicon, and nickel. It resulted from researches by Michael G. Corson in the laboratory of the Union Carbon and Carbide Research Laboratories during which the possibility of hardening copper by means of certain silicides became apparent.

When heated to 750 degrees to 800 degrees, centigrade, and then chilled, Tempaloy is soft and ductile and can readily be worked cold. Age hardening takes place when the alloy is held at 450 degrees for a few hours. It can be age hardened without cold working or after cold working, as may be convenient. Age hardening after cold working gives considerably higher results than age hardening of Tempaloy which has simply been softened by heating. Addition of aluminum strengthens Tempaloy appreciably and accentuates its hardening properties.

With the simple twist, the dentist "spots" a light where he wants it



Indians did not always have keen hearing. At the left is shown a normal ear cavity; at the right, hard tumors in the ear of an ancient Indian

Tempaloy, therefore, is a copper that can be tempered, or more correctly stated in modern phraseology, its properties are developed by heat-treating

Everdur and Tempaloy open the engineering field to copper. By suitable treatments they can be given such strengths that rods having cross-sections of one square inch would require pulls of 50,000 to 150,000 pounds to break them. Scientific research has thus produced two strong metals, resistant to almost all ordinary forms of corrosion and adaptable to numerous and varied uses. By industrial research in laboratories of the American Brass Company, both metals have been developed for practical application.—W. H. Bassett in *Research Narratives*.

Deafness in Ancient Times

We are so accustomed to think of Indians as possessed of the most acute vision and the keenest sense of hearing that we can hardly credit the statement that many Indians of ancient times were stone deaf. A common cause of deafness was due to the growth, in the outer ear passages, of numerous small, hard, ivory-like tumors which often filled the passages in both ears, preventng the entrance of sound waves. The condition was widespread among ancient Indians of pre-Columbian Peru, in a prehistoric tribe in Arkansas, in wandering bands of Indians found on the seacoast of southern California, and among aborigines living on the tiny island of San Nicolas, the most seaward of the California Channel Islands. Another type of deafness is due to the infections of the ears arising from large abscesses formed about the teeth.

An accompanying illustration shows the ear canal of an ancient Indian from Peru; another shows several small, hard tumors beginning to fill the passsage. Such tumors are not known among modern people.

Reproduced Daylight for Surgeons and Dentists

Surgeons and specialists in the hospital operating room, as well as the dental surgeons in their offices, have long felt the need of a proper method of illuminating their work. Through an invention of Dr. Leon Lazar, a practicing dentist of New York City, a lighting device has been conceived that is totally different from anything heretofore used.

The Lazar light is so constructed that several beams of light may be projected from different angles onto the spot where the surgeon or dentist is working. All beams are controlled from a single handle so that the operator can focus and merge all the beams into one spot of intense illumination, thereby giving a shadowless effect. Each light source is provided with a daylight filter which can be instantly snapped on to convert artificial light into reproduced daylight. Under this light colors and shades appear in their natural values, a feature that is indispensible in matching of teeth, porcelain fillings, and similar work.

The hospital unit with which surgeons may illuminate the point of the operation without a diffused and troublesome glare

This new light is made in three models: one, the hospital light, is for major surgery; another, the specialist light, is for nose, throat, mastoid, eye, and other minor operations; and the third is the dental light. Many dentists and a number of large hospitals are using these lights, and a number are in use by the United States Navy on battleships and at the Brooklyn Naval Hospital.

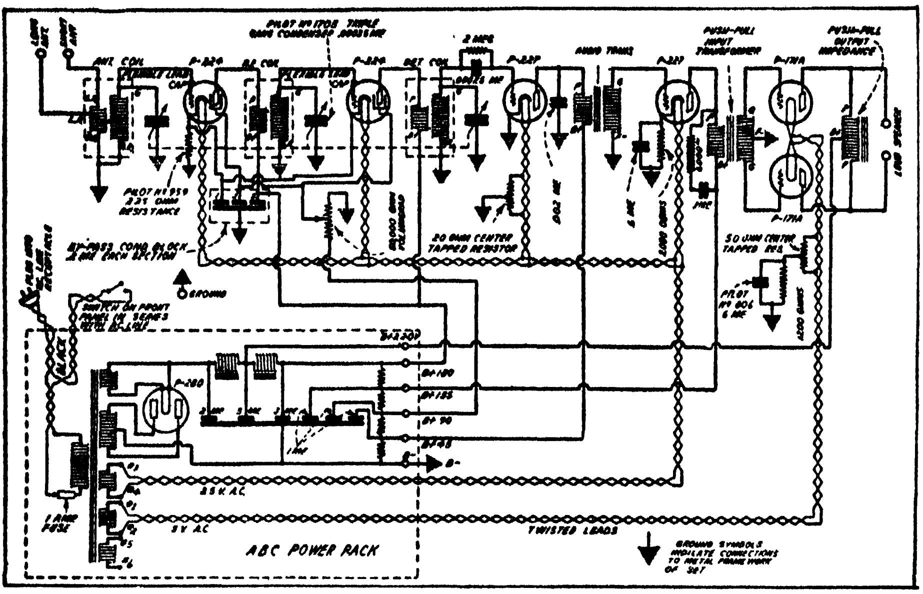
New Wrought Iron Process Eliminates "Puddler"

Egyptians made wrought iron thousands of years ago. This tough and long-wearing metal continued to be made by the same primitive means until the invention of "puddling" in 1784. This slow and expensive hand process is just now giving way to a revolutionary mass-production process developed by Dr. James Aston of the Carnegie Institute of Technology. Adopted by the A. M. Byers Company of Pittsburgh, it will abolish the picturesque "iron puddler" and bring this useful metal back to the many uses for which it has no adequate substitute.

1929 Sunspots Set 25-Year Record

One of the things for which 1929 will be remembered in astronomic circles is the record sunspots of its closing month. The spots on the face of the sun from November 24 to December 6 were pronounced at the time as unusual, and an examination of the photographic records of the sun for 25 years has confirmed the first impressions.

C. D. Higgs and F. E. Roach, of the Yerkes Observatory, Williams Bay, Wisconsin, have examined the thousands of


ANT. COIL
P-224
R.F. COIL
DET. COIL
P-227
P-171A
P-280
PILOT No 1708 TRIPLE GANG CONDENSER .00035 MF
2 MFD
AUDIO TRANS
PUSH-PULL INPUT TRANSFORMER
PUSH-PULL OUTPUT IMPEDANCE
LOUD SPEAKER
PILOT No 959 225 OHM RESISTANCE
BY-PASS COND. BLOCK .2 MF EACH SECTION
GROUND
20 OHM CENTER TAPPED RESISTOR
50 OHM CENTER TAPPED RES.
PILOT No 806 6 MF
SWITCH ON FRONT PANEL IN SERIES WITH AC LINE
BLACK
B-
2.5 V AC
5 V AC
1 AMP FUSE
ABC POWER PACK
TWISTED LEADS
GROUND SYMBOLS INDICATE CONNECTIONS TO METAL FRAME WORK OF SET

Circuit diagram of the kit-type receiver described herein

photographs made of the sun during the past quarter century, and they find that "there not only was as extensive an area of total spottedness as had ever been recorded in that interval, but also a single spot which probably was not exceeded in size."—*Science Service.*

A New Screen-Grid Radio

THE development of the screen-grid alternating-current tube has opened up a new field to the radio enthusiast. Using these tubes, enormous sensitivity can be obtained, but many experimenters have been disappointed with the results as regards selectivity. This has invariably been due to a lack of understanding of the new tubes and their application to receivers and has now been overcome for the radio constructor by the introduction of a complete, reasonably priced kit that can be made up into the commercial-appearing receiver illustrated in these columns.

This kit, which comes in three forms—the set alone with front panel, the set and a metal cabinet, and the set, cabinet, and a completely assembled power pack that delivers all the required A, B, and C voltages for all the tubes—can be assembled in a short time using only a screw-driver, a pair of pliers, and a soldering iron, even though the constructor knows little or nothing about radio. Every part, down to the last nut and washer, including wire, is furnished with the kit.

Screen-grid receiver in its metal cabinet. Note simplicity of controls—switch, tuning, and volume

A study of the circuit reproduced here will show at once that the set uses two screen-grid tubes, two A. C. tubes of standard design, and two 171A types in a push-pull audio amplifier circuit. Loose coupling between the antenna and the first radio-frequency amplifier insures ample selectivity for all purposes and makes possible the efficient use of single-control tuning. The volume control takes the form of a variable resistance in the screen-grid circuits, and a "tone equalizer" in the second audio circuit serves to suppress some of the higher tones and thus make the lower registers more prominent and pleasing. This equalizer takes the form of a resistance and condenser in series.

The necessity of shielding screen-grid tube circuits is met in this set by the use of aluminum shield cans totally enclosing the two screen-grid tubes and the three radio-frequency transformers. Most of the wiring is located under the sub-panel where it is out of the way and where it is easiest to install. The three variable condensers in the "gang" are provided with "trimmers" which are adjusted for best reception when the set is first placed in operation, after which they need not be moved.

Readers interested in this latest modern radio receiver kit will be supplied with further information upon request.

Chemical Kills Weeds but Lets Little Trees Live

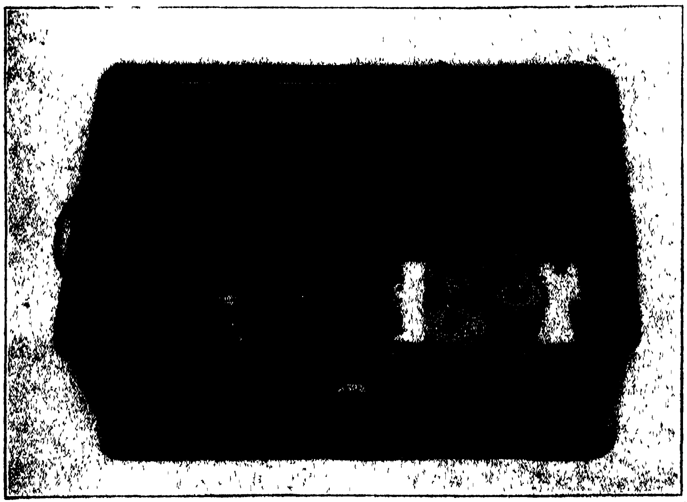
ZINC sulfate, sometimes called white vitriol, will kill weeds in a plant bed full of conifer seedlings but will not harm the little trees, Prof. Ferdinand H. Steinmetz and Prof. Fay Hyland, of the University of Maine, have found. They reported their discoveries recently to the American Society of Plant Physiologists.

Eight grams of zinc sulfate, dissolved in sufficient water and sprinkled over a square foot of ground, is most effective, it was learned. Germination of the seeds and growth of the little trees was only slightly reduced by the dose, while practically all the weeds were killed.—*Science Service.*

Earth as Power House Yields 200,000,000 Amperes

THE earth itself is a huge electric dynamo generating enough current to supply light, heat, and other electrical needs to the 10 largest cities in the United States for at least a million years. Recent researches on thermal reactions inside the earth, conducted by Dr. Ross Gunn, civilian scientist of the Naval Research Laboratories and inventor of a short-wave oscillator and airplane altimeter that have been taken up by the radio and aircraft industries, indicate that the earth is the greatest known electrical wonder in the universe.

Dr. Gunn has published a theoretical treatise on his studies in the *Physical Review.* The intricate theoretical problem of the earth's electrical condition showed that



Photographs courtesy Pilot Radio and Tube Corporation

Cover of cabinet removed, showing set chassis and powerpack. At right are shielded screen-grid tubes

Bottom view of set. Practically all wiring is below the sub-panel. Note the twisted leads that carry the A. C.

the currents generated inside the earth amount to more than 200,000,000 amperes. Dr. Gunn is careful to emphasize that this tremendous source of energy is unavailable for use by man. Like atomic energy, it will be kept in Nature's storehouse for use perhaps a million years in the future, he says.

According to Dr. Gunn, the tremendous electrical currents that are produced inside the earth arise from the motions of the tiny electrical charges known as electrons. The motions are caused by the very high temperatures existing inside the earth's crust.

Due to a peculiar and complicated type of interaction, the electrons are caused to drift around the earth's axis of rotation. This drift of electrons constitutes an electric current which is so large that, if it were sent through the huge cables supporting Brooklyn Bridge, it would melt them in less than a thousandth of a second.

The presence of the currents that flow in the hot interior of the earth may be detected by anyone who cares to observe the action of a magnetic compass on the surface of the earth, says Dr. Gunn, for it is precisely these deep-seated electric currents that orient the compass needle in a north-south direction. He adds that it has been known for thousands of years that the earth behaved like a giant magnet, but the mechanism by which this magnetism was produced was not understood.—*Science Service.*

Welded Steel Flooring for All Buildings

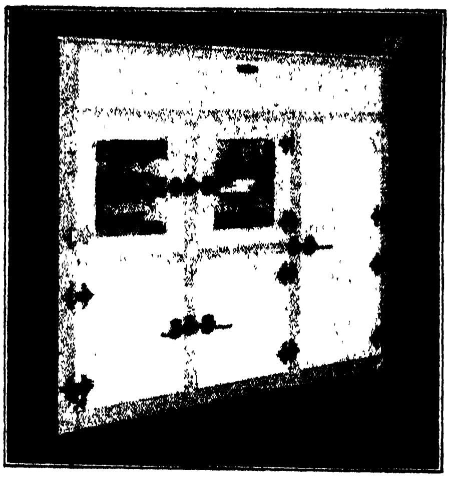
THE long-cherished dream of many architects and builders—to erect 100-story buildings—may now be realized as the result of the development of a new type of electrically welded flooring which materially reduces the weight of the structure. The new floor construction, known as the "battledeck" type, was announced and given its first public demonstration at the seventh annual convention of the American Institute of Steel Construction, Inc., at Biloxi, Mississippi, recently.

A sample structure was erected and a demonstration flooring was constructed in the presence of the institute membership, using steel plates and structural steel beams, the plates and beams being "stitched" together to form the flooring. The resulting structure met all specifications and tests satisfactorily.

A special electric arc welding machine, operating automatically, has been designed by the General Electric Company for this application and one of the new machines was used in the demonstration.

This machine consists of a three-wheeled self-propelled vehicle driven by an adjustable-speed motor. On the framework are mounted a wire-feeding device, a reel of welding wire, the travel motor, and the control devices. A motor generator at a remote point supplies, through a trailing cable, the current for welding and for operating the travel motor. The speed of travel and the speed of the welding-wire feed can be varied easily by adjusting small rheostats, thus making it possible to suit the operation to any particular circumstances. In the demonstration at Biloxi a satisfactory weld was accomplished at a speed of 9½ inches per minute.

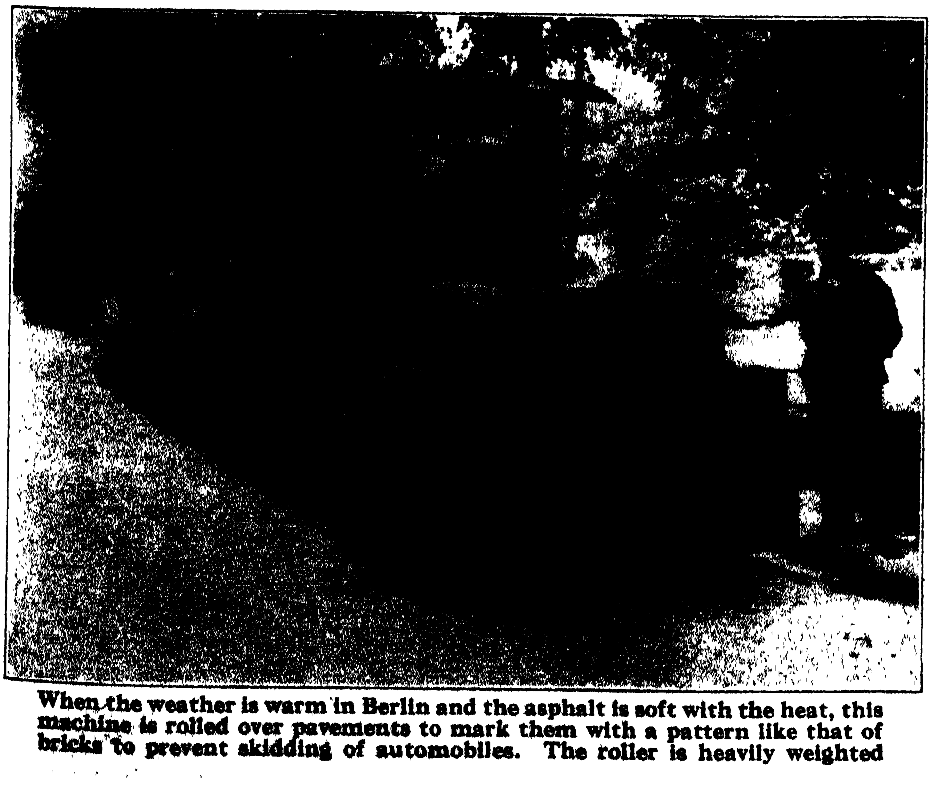
The outfit with which the seams of steel plate flooring are welded. Its operation is notably simple


A new development: 60 cubic foot commercial refrigerator cabinet

In operation the machine is placed on the beginning of a seam where it is lined up and started running. If by any chance it should tend to deviate from the seam during the course of travel, it can be steered by means of a small wheel on the mechanism. At the end of the seam it is merely necessary to turn the machine around and place it on the beginning of the next seam, proceeding from this point as before until all seams are welded.

The new floor is described by the Institute of Steel Construction as being a solid steel deck which acts as a girder to prevent any torsional distortion of the building when subjected to wind or earthquake action.

The new steel floor is equally applicable to residences, multiple-story buildings, and bridges, and for building construction it will save from 20 to 60 pounds per square foot of floor in dead weight. In connection with a 75-story building with floor panels 21½ feet by 22½ feet, the saving in dead load on the foundations for each column is nearly two million pounds, and indicates that its use will permit an increase of 25 percent or more in the height of the building or in the number of floors without increasing the loads on the foundations.


When the weather is warm in Berlin and the asphalt is soft with the heat, this machine is rolled over pavements to mark them with a pattern like that of bricks to prevent skidding of automobiles. The roller is heavily weighted

Commercial Electric Refrigerators

EMBARKING on a still wider field of operations with a new line of products, Frigidaire Corporation has announced a series of porcelain commercial boxes, constructed along principles which have already proved successful in the household refrigeration field, and designed to meet the requirements of virtually every kind of retail business.

The new boxes are of 35, 60, and 110 cubic foot capacity. The smallest is similar to an enlarged household model, having four service windows. The two larger models have a full length door besides the four windows. This door gives access to a meat rack for hanging quarters of meat. Engineers pointed out that three sizes were selected after an exhaustive study of the most popular sizes for commercial refrigerators.

E. G. Biechler, president and general manager of the corporation, in announcing the new boxes, emphasized the fact that the company will continue to make refrigerating equipment to be used with other makes of refrigerators, but in addition now is able to provide a box engineered exclusively for electrical refrigeration and covered by its standard factory guarantee.

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

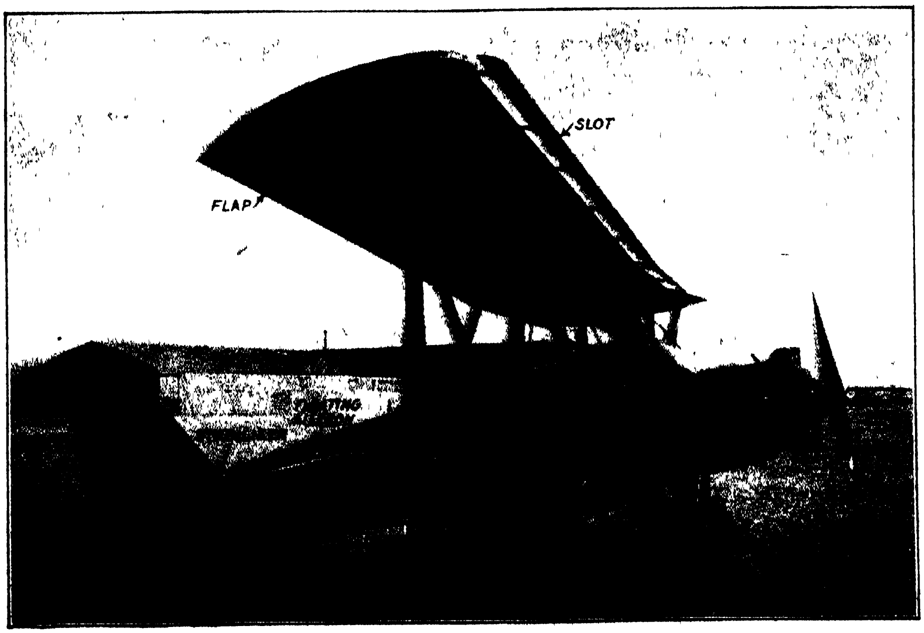
CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York City

The Safe Aircraft Competition

FROM the writer's personal view of the recently closed Guggenheim Safe Aircraft Competition, in which the Curtiss *Tanager* was the only one to qualify, there emerge the following conclusions:

1. The speed ranges as advertised by our manufacturers, that is, the range between maximum and minimum flying speed, are greatly over-estimated. Those which such manufacturers advertise, in all honesty, are apt to shrink considerably when submitted to the acid test of independent and accurate testing. If the competition makes this clear to industry and public alike, it will have achieved a real service to aviation.



A side view of the prize-winning *Tanager*, with the various important parts indicated and named. These features are described on this and the opposite pages

2. It is far more difficult to diminish the minimum speeds, and hence the landing speeds, than to increase the top speeds. Dr. H. E. Wimperis, of the British Air Ministry, points out that the speed of a British fighting plane was increased by 70 miles an hour in the course of a single year. As demonstrated by the Schneider Cup Races there seems to be no limit to the speed of our racing aircraft. At the lower end of the range, progress seems to be much slower and the conventional airplanes, such as many of those entered in the competition, frequently have stalling or minimum speeds of well over 45 miles per hour.

3. The only way to achieve progress at the lower point of the speed range, without sacrifice of other good qualities, is to adopt some device for increasing the maximum lift coefficient of the airfoil.

4. The competition indicated that variation of the camber alone, or variation of the angle of incidence, were not very effective methods of improving the landing speed. It was most unfortunate that one entry which embodied both variable area and camber was not ready in time to undergo tests.

A reproduction of the check tendered to the designers of the qualifying Curtiss *Tanager*. Requirements of the competition are put forth on the opposite page

5. The competition indicated quite clearly that the slot, acting in conjunction with a rear flap, was at that date the most powerful and the most practical means of improving the lower range of the aircraft. It indicated further that the slot and flap could be embodied in the design of an airplane without any undue complication and without any danger of failure in flight. Both the Curtiss entry, the *Tanager*, and the Handley Page entry carried the front slot and a rear flap. These planes suffered, in the exceedingly severe tests of the competition, a variety of mishaps such as broken landing gears and damaged tail skids, but at no time did the slot and flap offer any difficulties either in reliability or in pilot's operation.

6. The Curtiss Company has announced definitely that it will put the *Tanager*, a cabin biplane, into production. We believe that other American manufacturers will be convinced soon that slots and flaps belong in the modern airplane, and that their use will become general in a few years.

Considering the *Tanager* in some detail, there will be noted first of all, that there is the slot, consisting of an auxiliary airfoil mounted at the leading edge of the main wing. When at high angles of incidence, with the suction on the upper surface of the wing concentrated towards the leading edge, the small auxiliary airfoil mounted on a suitable form of roller moves forward automatically and creates a Venturi-like passage between the auxiliary airfoil and the main wing. The streamline flow, destroyed by the high angle of attack, is immediately restored by this passage which allows an auxiliary flow from the region of high pressure below the wing to the region of low pressure above the wing.

The opening of the slot allows the wing to go to an incidence of some 24 degrees, instead of the usual 16 before "burbling" of the air flow occurs. The lift is thereby increased some 40 percent for a thick wing, and some 60 percent for a thin wing. It is difficult to use the action of the slot alone, because to take advantage of its lift-increasing property, it is necessary to have an airplane whose angle of incidence at landing is high. The chassis, to realize a three point landing with front wheels and tail skid touching at the same instant, must be long and stilt-like. This decreases the performance of the aircraft because the weight and air resistance of the landing gear increase with its length.

If, however, a rear flap is placed all along the rear edge of the wing, the situation changes. First of all the use of the rear flap in conjunction with the front slot increases the lift not some 40 to 60 percent, but over 100 percent! Secondly, the depression of the rear flap brings down the angle of incidence at which maximum lift is achieved to normal proportions, and the landing gear design need no longer depart from convention.

The front slot can be suitably linked up with the rear flap, so that the action of the rear flap is also automatic. As the front slot opens it pulls down the rear flap. As the front slot shuts, the rear flap gets in line with the wing as should be the case within normal flying speeds.

The Handley Page entry had the rear flap interconnected in this manner. The designers of the Curtiss *Tanager* preferred to place the control of the flap in the hands of the pilot.

Experience in the competition seemed to indicate that the manually controlled flap is preferable. The automatically controlled flap has a tendency to take charge itself and to shut the front slot just when its help is needed the most. This is because the air presses up on the flap and tends to raise it at all times, so that the flap and slot are, so to speak, working against one another.

Another important feature of the Curtiss entry was the floating aileron. In order to achieve the maximum possible increase in lift, it is advisable to have the rear flap run the entire length of the wing span. Hence the ailerons should, if possible, be outside the wing system proper. Also, the conventional aileron acts least effectively at high angles of incidence and low speed, when it is required the most. The floating aileron as used by the Curtiss company gets around this difficulty. The ailerons are so arranged that they float in the air stream and are always at zero angle of incidence, although they can at the will of the pilot be raised and lowered on respective sides so as to achieve lateral control.

The great advantage is that the ailerons always start from a neutral incidence and are therefore effective no matter what the incidence of the wing as a whole may be. Further, since the ailerons are symmetrically double-cambered surfaces, when one is lowered and the other raised their air resistance remains the same because of this symmetry. Hence the ailerons introduce no unequal resistance at the tips of the wing, and no tendency to turn the machine off its course.

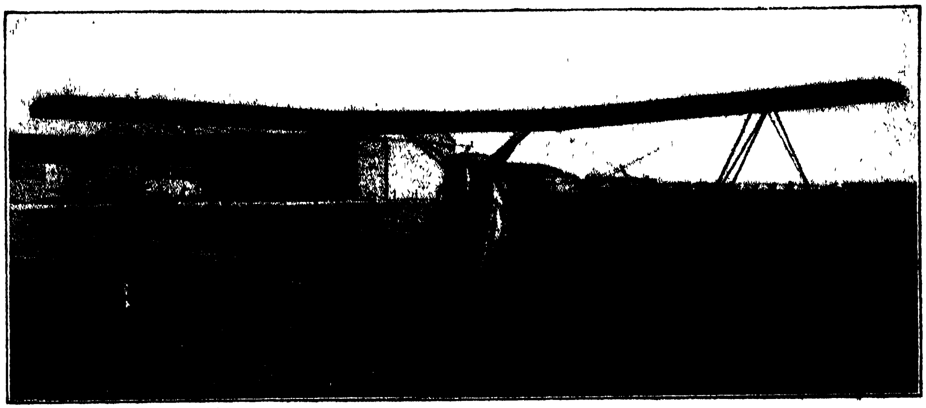
Still another feature of the *Tanager* is the rapidly adjustable stabilizer which can be moved through a far greater range than the ordinary adjustable stabilizer. At very high angles of incidence, with the flap depressed, the center of pressure tends to move back, and it is hard to keep the machine in the high angle of attack condition. The rapid and powerful adjustable stabilizer action takes care of this difficulty.

The main dimensions of the *Tanager* were as follows:

Spar—43 feet 10 inches (for both wings)
Chord of both wings—5 feet
Wing area—330 square feet
Overall length—26 feet 7 inches
Weight empty—1900 pounds
Useful load—850 pounds
Engine—170 horsepower Curtiss "Challenger"

The exact performance of the *Tanager* in the competition has not yet been released, but our readers will appreciate its performance sufficiently well if they note that the plane satisfied all the requirements of the competition, although only by a narrow margin. These requirements were:

Useful load per horsepower—5 pounds
High speed—110 miles per hour
Climb—400 feet per minute
Low speed—power on—35 miles per hour
Minimum gliding speed—power off—38 miles per hour
Length of landing run—100 feet
Steady glide over an obstruction 35 feet high, and coming to rest 300 feet from base of the obstruction
Length of take-off, 300 feet
Take-off over an obstruction 35 feet high at a distance of 500 feet from rest
Flattest glide of 8 degrees to the horizontal
Steepest glide of 12 degrees to the horizontal at a speed not exceeding 45 miles per hour.

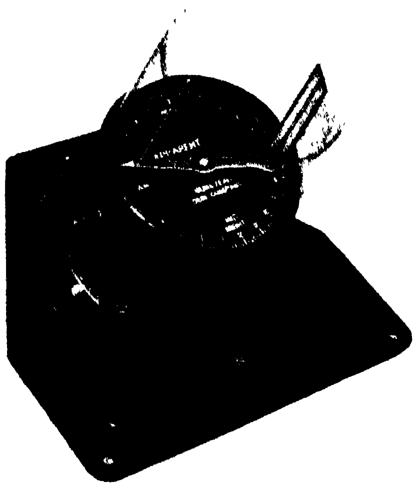


Looking at the *Tanager* from the rear. This photograph shows plainly, at the lower wing tips, the two ailerons which are always at a zero angle of incidence

The Sun Compass

TO establish a course, the pilot has the conventional magnetic compass and the more refined earth inductor compass. Both types are fairly satisfactory everywhere, except near the poles where the magnetic directing force becomes too uncertain.

Accordingly, for his successful flight over the South Pole, Commander Byrd had recourse to an instrument operating on a totally different principle—the sun compass. The sun compass is a clock with a single hand, moving at the same speed as the earth about the sun. The face of the clock bears the usual hour divisions. The tip of the hand carries a needle and the base bears a screen marked with two perpendicular lines. The sun casts a shadow of the pin on the screen.



The Bumstead sun compass

Before starting from Little America, Commander Byrd set the hand of the clock at true solar time. He turned the entire instrument until it read due south, as indicated by the compass markings on the base plate. Then he moved the latitude scale and set it at 90 degrees, the location of the pole. When the party took off, the pilot swung the plane until the sun cast the shadow of the pin between the lines of the screen, where it was held until the goal was reached.

Inasmuch as the hand of the clock makes one revolution in 24 hours and the earth makes one complete revolution in the same time, the compass and the hand of the clock remained in a constant relative position so that a straight line might be maintained.

When Commander Byrd reached the South Pole and turned for his base, he rotated the base plate until it read north instead of south, and the airplane was again directed to bring the shadow of the pin back on the screen.

Air Transport Communication

R. L. JONES and F. M. Ryan, of the Bell Telephone Laboratories, in a paper delivered recently before the American Institute of Electrical Engineers, dealt with the very important subject of telephone communication between plane and ground.

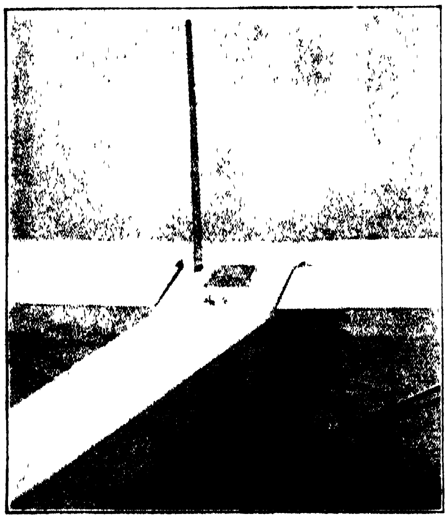
In air transport work the dependence on weather conditions makes it an absolute essential of safety that there be frequent and complete communication between the pilot and the ground. Radio telephony is preferable to radio telegraphy as it requires no skilled operator and is much more rapid.

The problem of establishing such radio telephone service presents many difficulties, but the engineers of the Bell Telephone Laboratories, using a large three-engined plane as their flying laboratory, have practically solved it.

The experiments conducted at Whippany, New Jersey, furnish another argument for high altitude flying. Both the strength and the intelligibility of the telephone signals are improved when the plane is high above the ground.

The antenna is quite a problem in aircraft radio. For reception, all that is needed is a self-supporting, stream-lined mast of hollow wood construction, with an internal conductor, and extending about seven feet above the fuselage. For transmission, however, such masts are not generally suitable. The frequency band for aircraft radio telephony is between 1500 and 6000 kilocycles. It is the lower frequencies which give the best results, but for this work, long trailing wires are essential. It may therefore be necessary, in

Owing to the high noise level in airplanes, a special type of telephone transmitter must be used. Here is the hand type which has been developed for this use



A general type of self-supporting stream-lined mast antenna widely used for airplane radio receivers for the reception of weather reports and signals from beacon stations

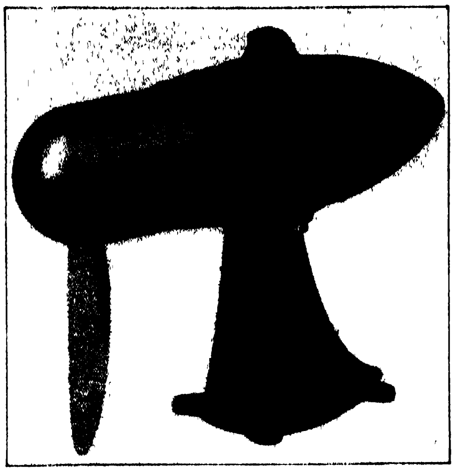
air transport work, as distinct from military aviation, to use the less suitable higher frequencies because they permit of fixed antennas of relatively small dimensions.

Aircraft radio telephony must meet many unusual requirements. There is first of all the noise of engine, exhaust, and propellers to overcome and in the design of both the microphone and the receiver, special precautions must be taken to exclude external sounds.

Another problem is in the violent electrical disturbances introduced by the usual ignition system of the aircraft engine. Magnetos, the electric ignition circuits, and the spark plugs, must all be electrically shielded. Here is another argument in favor of the Diesel engine; it will dispense with the ignition system and thus aid radio telephony.

Again, it is necessary to bond all metal parts of the airplane, in order to avoid noises in the receiving equipment from intermittent contacts between various metal parts of the plane. When transmitting apparatus is used on board an aircraft, such bonding is also necessary to prevent the possibility of high voltages developing between metal parts and causing sparks or arcs.

At the moment radio telephony reception is probably more important in air transport than transmission. The aircraft receiver for government weather signals is a comparatively simple affair. It is equipped with three tuned circuits—one for the antenna and one for the output circuit of each of the stages of radio frequency amplification. The receiver is mounted in a metal box about 12 inches long by 8 inches high, and weighs only 18 pounds. A small electric generator supplies the necessary power; it is driven by propeller, which is one-bladed, and the centrifugal force of the unbalanced blade actuates a governor so that speed and output remain constant, no matter what the speed of the airplane may be.



A single-blade wind-driven generator of the type used to supply filament and plate voltages to the receivers used on airplanes. The speed and output are constant

The special telephone set used by the pilots in airmail planes. The receivers are in the helmet

Another characteristic of radio telephony is the special headphone which is used by the pilot and the special telephone-type transmitter which may be fastened to the head or held in the hand.

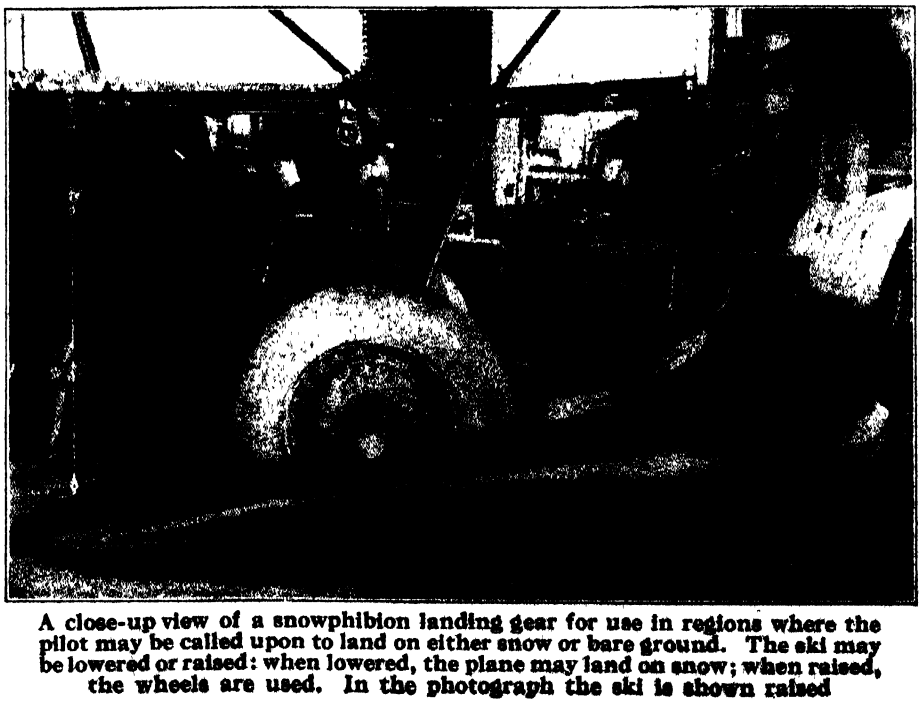
Beryllium

MUCH interest has been aroused by various notices which have appeared in this magazine concerning the extraordinary light metal beryllium. In our January issue, on page 89, mention was made of the cost of beryllium ore at about 60 dollars a ton. This high price, it is hoped, will be greatly reduced in the near future so that the price of approximately 225 dollars a pound for the refined metal may be placed at a level where it will not be prohibitive to the industrial development of uses for the material.

Snowphibions

SNOWPHIBIONS is a recently coined term to designate airplanes which can alight on dry land or on snow indifferently, in analogy with the amphibion which can alight on water or land. The snowphibion built by the Boeing Airplane Company is being put in use on their airline between Chicago and San Francisco, where differences of climate over the long stretch make it uncertain whether snow is to be expected or not.

The snowphibion is provided with a long ski, something like a pontoon in construction. This is pivoted about the wheel axle, with the pivoting motion restrained by rubber cords. Also, by a mechanism analogous to that of the retractible chassis, the ski can be raised or lowered relative to the wheel axle. When lowered, the plane lands on the ski; when raised the wheel is free to act as usual.



A close-up view of a snowphibion landing gear for use in regions where the pilot may be called upon to land on either snow or bare ground. The ski may be lowered or raised: when lowered, the plane may land on snow; when raised, the wheels are used. In the photograph the ski is shown raised

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Engineering

Manual of First-Order Leveling, by Henry G. Avers, (Special Publication Number 140, U. S. Coast and Geodetic Survey) contains general instructions for this type of surveying, as revised to conform to the present accepted practice. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

Construction, Rehabilitation, and Maintenance of Gravel Roads Suitable for Moderate Traffic, by Carroll C. Wiley (Circular Number 18) is a well illustrated report covering investigations and tests made concerning the methods, materials, and equipment best suited for gravel highways. *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—30 cents.*

The Mojave Desert Region in California, is a 759-page book with accompanying maps giving complete information about the geographic, geologic, and hydrologic features of one of the continent's most interesting regions, covering an area of about 25,000 square miles. *U. S. Government Printing Office, Washington, D. C.—Two dollars.*

Design Standards for Oxwelded Steel and Wrought Iron Piping is an illustrated booklet prepared to enable the engineer and architect to design piping systems according to the best practice yet developed. *Linde Air Products Company, 30 East 42 Street, New York.—Gratis.*

Commerce

Market Data Handbook, a 535-page compilation of authoritative statistical data, covers the entire country by counties. The information is arranged in convenient classifications for reference use, showing the localization of all industries as a guide to aid sales managers, manufacturers, advertisers, *et al.* The book is issued by the Department of Commerce. *U. S. Government Printing Office, Washington, D. C.—$2.50.*

Coal Bunkering Stations and Fuel Oil Stations, a new fueling directory covering 300 world ports, has been prepared by the Shipping Board and the Department of Commerce, from data collected by the Department of State through its consular officers. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

Foreign Commerce and Navigation of the United States, is a 661-page volume containing classified statistical and summary tables for 1928 and comparative years, covering all United States foreign trade. *U. S. Government Printing Office, Washington, D. C.—$1.50 (buckram bound).*

Wood

Small Dimension Stock, its Seasoning, Handling and Manufacture, is a report of the National Committee on Wood Utilization, the 12th of a series on the marketing and use of lumber. The purpose of the report is to develop standard methods of small dimension production, by detailed recommendations. *U. S. Government Printing Office, Washington, D. C. - 20 cents.*

The Story of American Walnut begins with the days of King Solomon, marches down the centuries with the master woodworkers of various periods, and concludes with a lesson on means of identifying and judging walnut furniture and interior woodwork. *American Walnut Manufacturers' Association, 616 South Michigan Avenue, Chicago.—Gratis.*

Miscellaneous

Abstracts of Dissertations for the Degree of Doctor of Philosophy (1929) covers numerous papers dealing with specialized topics in science, education, history, and classical literature. An appendix covers the activities of the Graduate School. *University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

Brief of Walter H. Wheeler, applicant for a permit to produce hydro-electric power for phosphate fertilizer manufacture on the Flathead River in northwestern Montana. This brief shows clearly the plans, as presented before the Federal Power Commission, for the development and utilization of power from "the Muscle Shoals of the West." *Forbes and Daniels, Kellogg Building, Washington, D. C.—Gratis.*

Manual for Bird Banders, by Frederick C. Lincoln and S. Prentiss Baldwin, (Miscellaneous Publication Number 58, Department of Agriculture), describes and illustrates many approved types of traps and contains much information in regard to ornithological research. *U. S. Government Printing Office, Washington, D. C.—30 cents.*

Some Social and Economic Aspects of Homework, Special Bulletin No. 158 published by the New York Department of Labor, treats the problem of homework from the viewpoint of the statistician interested in effecting curative measures. *Department of Labor, 124 East 28th Street, New York City.—Gratis.*

Black Horse of the Sea, by Robert D. MacMillen, is a handsome booklet describing the salvage service symbolized by a runaway black horse, known for nearly 70 years by sea-faring men. *Merritt-Chapman and Scott Corporation, 17 Battery Place, New York City.—Gratis.*

Rare Metals is a booklet presenting in very readable form the history, properties and uses of the metals tantalum, tungsten, and molybdenum. *Fansteel Products Company, Inc., North Chicago, Illinois.—Gratis.*

Tantalum, described in the booklet "Rare Metals," is obtained from a remote district in Australia. The inset shows the ore, powder, and a tantalum bar

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

New Process Enables Metal Coating to be Sprayed on Anything

METALLISATION, as its name implies, is a process by which articles are covered with a metal layer. The latest developments of this process make possible such startling achievements as the spraying of molten metal on such delicate surfaces as paper, cloth, and celluloid, forming a coating so adhesive that it seems almost an integral part of the base. Usually the metal which is to be deposited is employed in the form of a wire, although metal dust or powder may be used if another apparatus is employed.

The usual apparatus consists of a pistol, weighing about three pounds, connected to cylinders of oxygen and acetylene, and to a source of compressed air. The compressed air actuates a small turbine which feeds the wire—supplied from a reel—through the nozzle of the pistol, where it meets the oxy-acetylene flame and is melted, the compressed air atomising the molten metal and forcing it at high velocity—some 3000 feet per second—against the object which is being coated.

The rate at which the wire is fed through the nozzle varies according to the nature of the wire, control being provided by a needle valve which adjusts the air flow to the turbine. As the flame is of a reducing nature, the atomised metal is protected from oxidation, hence metallisation can be continued until the desired thickness of coating, from 0.001 inch upwards, is attained. A pleasing matte finish is obtained, which can be buffed if a polish is desired.

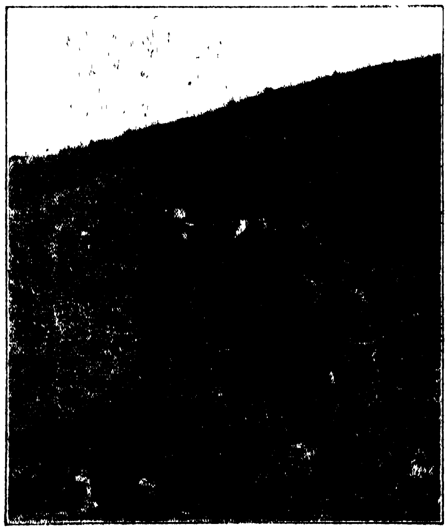
The only precaution required, apparently, is to ensure that the surface to be metallised possesses an open texture—metal articles should be sand blasted, using dry sand—and that it is perfectly clean and free from moisture, scale, or oil. Paper, cloth, and wood can be metallised without trouble, but the paper must not be glazed, and wood should be sand-papered or given a light passage in the sand blast. It should be remarked that there is very little heat effect on the surface of the work; therefore delicate materials such as celluloid or a photographic film can be treated without harm. The coating is extremely adherent, and cannot be separated from its support, either by bending or severe hammering.

Simple Device Measures Explosive Gas in Mines

A RATHER clever device for the determination of the amount of the explosive "fire-damp" gas in mines has been perfected in England. The principle of its operation is chemical, being based on the fact that one volume of methane, when burned, produces two volumes of steam. The steam condenses, producing a reduction of pressure, the reduction being proportional to the amount of methane burned. The methane is burned in a copper combustion chamber containing an electrically heated platinum spiral and connected with a U-tube liquid gage graduated to read directly in percentages of fire-damp.

Chemists Pre-Determine Relative Corrosiveness of Soils

THREE billion dollars a year is lost by the corrosion of iron and steel, according to Dr Edward R. Weidlein, director of the Mellon Institute of Industrial Research. It is small wonder, therefore, that methods of reducing this staggering waste occupy the attention of chemists in many industries. One very large item on this corrosion bill is that charged against the corrosion of pipe lines, for distributing gas, oil, and water. W. T. Smith, in a recent issue of *Chemical and Metallurgical Engineering* describes how chemists analyze the soil in which the pipe is to be laid and thus determine the best methods of protecting it against corrosion.



Soil samples are taken, at intervals of not more than one mile, by means of an auger, to the depth at which the pipe will lie when in service. Wherever definite changes in topography or surface conditions are encountered, additional samples are taken, as are liquid samples from any streams or rivers the line may cross. Each representative sample is placed in an air-tight container marked with specific information for identification at a later date.

When the samples arrive at the laboratory they are weighed as received, air-dried, and weighed again to determine the moisture content. A solution is made by thoroughly mixing a portion of each sample with distilled water. Both the solution and the soil are then subjected to a carefully worked-out series of chemical analyses to determine the amount of certain constituents known to be active factors, under certain conditions, in accelerating or inhibiting corrosion. In addition to the chemical analyses, each sample is subjected to determinations for hydrogen-ion concentration and physical, electrolytic, and accelerated corrosion tests.

Courtesy J. W. Richards & Son

Left and above: **Taking samples of soils along a pipeline for use in charting the relative corrosiveness**

When the complete analytical data has been calculated and charted, an equally important part of the corrosion survey begins. It is one thing to "analyze" a soil and quite another to interpret the knowledge gained in terms of relative corrosiveness. By means of a method worked out

Courtesy Wailes Dove-Hermiston Corporation

Coating pipe with Bitumastic enamel by the rolling-rig method; from the facts revealed by the corrosion survey, coating specifications are made

by Percy J. Richards, of J. W. Richards and Son, and William Thompson Smith of Ford, Bacon and Davis, Inc., all the known and suspected corrosive factors are correlated and balanced against each other. As mentioned above, these factors include surface conditions, analytical data, moisture, and any other local situation that may be of importance. The result is interpreted in terms of relative intensity of corrosive action at all points along the pipeline, with specific recommendations as to the amount of protection necessary on varying sections.

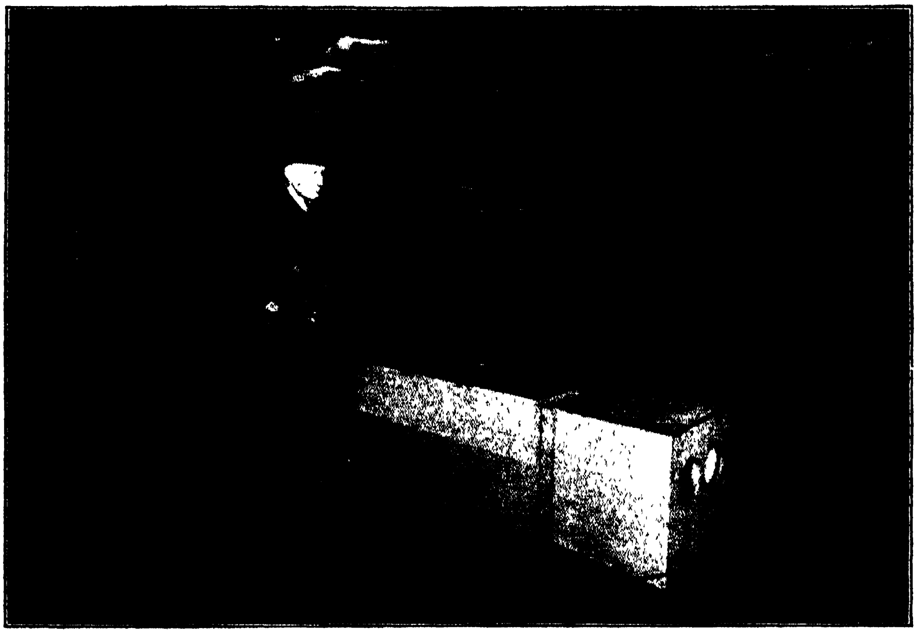
Electrical Eye Detects Smoke

An electrical smoke detector is the latest example of the invasion of the "mechanical man" into the field of the chemist. Scientists of the General Electric Company have developed a machine that is so sensitive to the existence of smoke or haze in air that it immediately reports the situation. We have previously described, in these columns, several of the ingenious devices used to detect poisonous carbon monoxide in the mines and tunnels, such as the Holland Tunnel connecting New York and Jersey City. Now we present the electrical eye which detects excess haze or smoke in this tunnel, thus warning the superintendent that the ventilating fans should be speeded up.

In applying the light-sensitive photo-electric cell to tasks of this kind, Ole Singstad, Chief Engineer and Superintendent of the Holland Tunnel, hopes to work important operating economies and to provide an additional safeguard in controlling the air conditions in the tunnel. As now used experimentally in the tunnel, the "electric eye" is directly connected to a recording device a quarter of a mile from the mouth of the tunnel. Impulses from the photo-electric cell circuit guide a pencil point over a sheet of paper graduated in time and in volume. At any instant the supervisor knows how much haze is in the tunnel, and if the visibility decreases from any cause whatsoever he can relieve the situation by speeding up the fans or by putting additional fans into service.

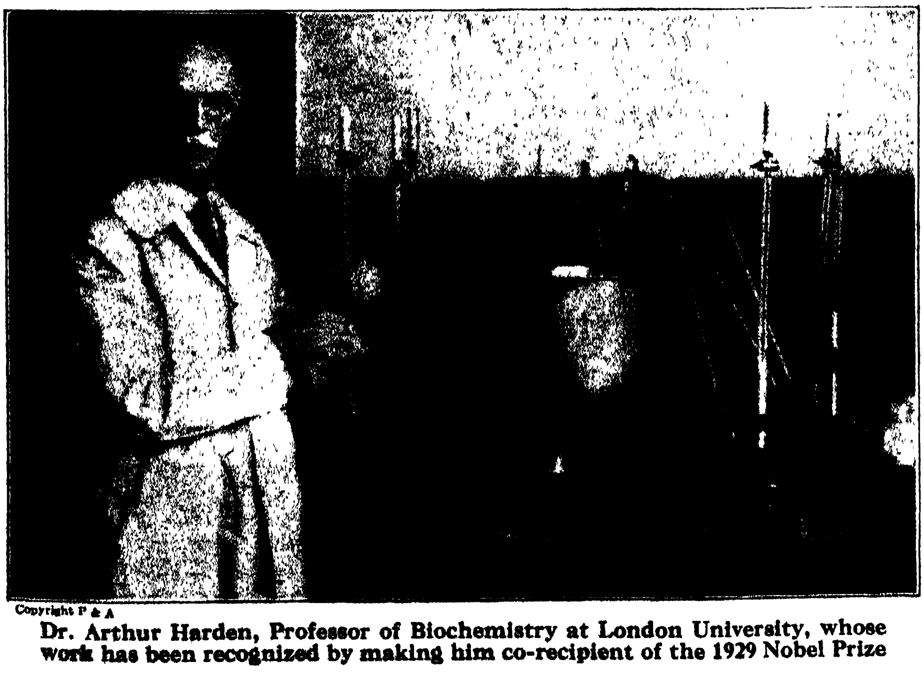
At the present time the detector is located in an exhaust duct, a long cave-like chamber above the traffic lane, near the New York exit and at the point where the roadway grade is at the maximum and where the amount of exhaust gases expelled from the heavy truck traffic is greatest. The exhaust duct is dark except for fitful beams of light admitted through narrow openings in the roof of the passage way. These openings provide an exit for the air.

The detector consists of two units, a light source and a photo-electric cell and, 150 feet away, a target. Light provided from a lamp with concentrated filament is directed through a lens to the distant target. This target consists of two mirrors set at right angles. The light beam hits the first, which directs it to the second mirror and thence is reflected back 150 feet to the light-sensitive tube.


The "electrical eye" now being tried out in the Holland Tunnel under the Hudson River; the photo-electric "eye" detects the presence of excess smoke

As the exhaust air of the duct passes through the light beam, the quantity of the light is diminished. This variation or dimming of the light is not perceptible to the human eye but the photo-electric cell responds to the most minute changes. The greater the amount of light, the greater the current passing through the tube. The photo-electric cell, which is about the size of the familiar "peanut" radio tube, is directly connected to an amplifier where the current is built up, and passed on to the recording device a half mile away.

The projected use of the photo-electric cell as a fume detector may presage the development of a household and business house robot watchman, which will be a smoke detector that will sound an alarm at the first appearance of smoke on the premises. A photo-electric cell and a light source might be installed in cellars, in attics, or in warehouses filled with combustible goods. Such a tube connected to a bell or some other form of alarm could be depended upon to give warning with almost the first appearance of smoke.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Dr. Arthur Harden, Professor of Biochemistry at London University, whose work has been recognized by making him co-recipient of the 1929 Nobel Prize

Coats Aluminum With Lime as Base for Paint

Aluminum articles, when boiled with milk of lime containing a little calcium sulfate, are given a fine-grained, closely adherent, dead-white coating which may prove to be an excellent foundation for the application of paints or enamels, says Leon McCulloch, in a recent issue of *Chemical and Metallurgical Engineering.* The coating probably cannot be recommended for corrosion resistance but it gives a surface that can be written upon. If alloys of aluminum rather than the pure metal are given the treatment, various shades of gray are obtained.

In applying the coating, ten grams each of lime and calcium sulfate (preferably the fully hydrated sulfate) are used for each liter of water. Although the action of the calcium sulfate is unknown, it is found to give smooth, adherent coatings which would otherwise be pitted.

As there is apparently deterioration of the bath upon aging, fresh materials should be added each day. The bath is stirred gently and is kept at about the boiling point, although a temperature of 85 degrees, centigrade, has given satisfaction. Time for the process may vary slightly, although the coating does not increase ap-

(*Please turn to page* 245)

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Cause of Influenza

IN 1892 a bacteriologist named Pfeiffer described a germ which he thought was the causative organism of influenza. At various intervals since that time other organisms have been described, also alleged to be causative, and the bacteriologists continue to debate the question as to the exact nature of the influenza germ.

Modifications of the Pfeiffer organism have been described every year, associated with various coughs, colds, and similar infections of the nose and throat. It is emphasized that the various types of germ described as Pfeiffer organisms do not constitute in any instance a unit; that is to say, they are not uniform in distribution or in the way in which they bring about disease.

During the last great epidemic of 1918, organisms were recovered from thousands of cases all over the world, and there is no evidence that uniformity exists even in the many types of organism associated with that epidemic.

In attempts to discover and definitely to identify the influenza germ, experiments have been made with human beings who voluntarily submitted themselves to inoculation with pure cultures of the various germs that have been isolated. The earliest definite report of successful human inoculation with pure culture of the Pfeiffer organism is that recorded by Dr. D. J. Davis in Chicago in 1906.

However, Doctor Davis pointed out at the time that while the Pfeiffer germ may produce definite symptoms on inoculation into human beings, the symptoms produced are not those of true influenza.

During the 1918 epidemic, volunteers were inoculated with 13 different strains of organisms isolated from cases of influenza. All of them developed symptoms, but again it was shown that these symptoms were not the typical symptoms of epidemic influenza.

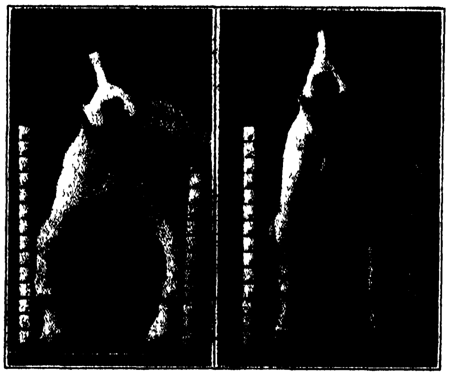
Indeed, after surveying all of the evidence of innumerable inoculations with all sorts of organisms taken from the nose and throats of people during epidemics, Prof. E. O. Jordan comes to the conclusion that it can not be definitely asserted that negative inoculation experiments are not in themselves sufficient to rule out Pfeiffer's organism as the cause, since it is quite possible that there are some unknown factors influencing the likelihood of a person to catch influenza or associated with the way in which the organism is transferred from one person to another. After death from influenza no uniformity of kind or distribution of bacteria can be detected in the body.

During influenza the resistance of the body is lowered and a great variety of germs invade the tissues. As a result, all sorts of bacteria have been found in influenza and the medical profession has become exceedingly suspicious of new discoveries in this field.

Until a germ isolated by any investigator has been thoroughly tested by independent investigators under various conditions in different hospitals and laboratories, it is not safe to accept it as the causative germ of this extremely difficult and elusive malady.

Of the organisms given most serious consideration in recent years, the green-producing streptococcus isolated by Mathers and Tunnicliff in 1918, the one discovered by Rosenow in 1919, and innumerable similar germs isolated in various parts of the world immediately thereafter deserve special consideration. The filter-passing organism described by Meyer in 1919 and the organisms discovered by Olitzky and Gates of the Rockefeller Institute and called by them *bacterium pneumosintes* would seem to deserve as much consideration as is now given to the Falk germ recently announced as the cause of this disease.

Recently investigators in the University of Chicago have carried out a series of experiments on human beings and on animals and have isolated an organism which they feel is the specific cause of influenza. Four monkeys were inoculated with the Pfeiffer bacilli, but did not develop symptoms resembling influenza in man. Such symptoms were developed in 16 monkeys which were inoculated with material obtained from eight human beings who were suffering with influenza. Cultures of bacteria developed from the secretions of patients with influenza were sprayed into the nose and throats of the monkeys and these monkeys developed symptoms resembling influenza. Monkeys which had developed symptoms following inoculation with cultures were put in cages with other monkeys, and the other monkeys apparently caught influenza from the infected monkeys. There were controls made by spraying the nose and throats with salt solutions and non-infectious material, and monkeys sprayed with these materials did not develop any of the symptoms referred to. During the course of the investigation, several of the workers developed symptoms resembling those which are caused by influenza.



Two female dogs from the same litter, one of which, left, received as the primary constituent of its rations 66.9 percent of untreated oats; the other received the same quantity, commercially irradiated. The rest of the ration consisted of skimmed milk powder, casein, alfalfa, sodium chloride, and tricalcium phosphate

Unfortunately it is difficult to interpret these results, due to the fact that it is hard to tell clinical epidemic influenza from other respiratory infections both in monkeys and in man. A great deal more work must be done under controlled conditions by workers in other laboratories before a certain appraisal can be placed on the value of the work already accomplished.

Irradiated Cereals

WORKERS in Wisconsin in the department of agricultural chemistry showed in 1923 that the food taken by a rat could be exposed to ultra-violet and in that way serve to prevent rickets in the rat. Later numerous investigators throughout the world showed that a definite compound, ergosterol, is the substance which is rendered potent against rickets by exposure to ultra-violet rays. The workers in the University of Wisconsin later developed methods for irradiating rolled oats and other cereals, and such foods are now generally available for use in the average home.

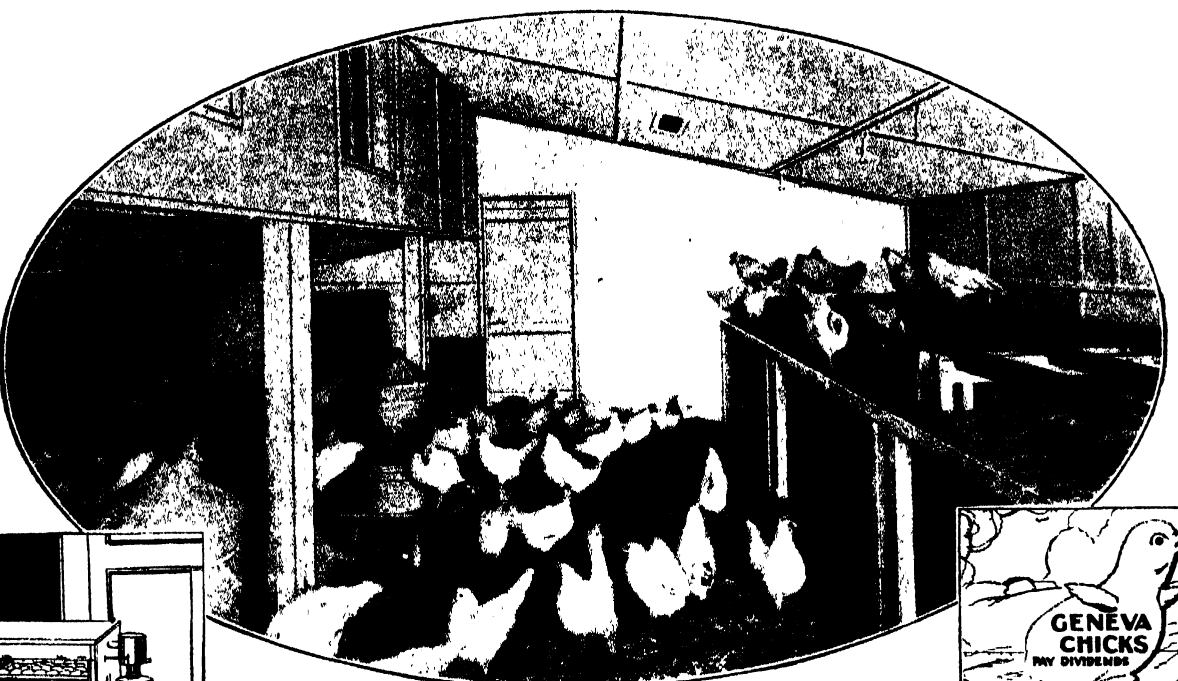
It has been shown by experiments on animals that rickets may be prevented by feeding such products to them. The irradiation does not seem to destroy the other vitamins that are in the food, nor does the irradiation of the food produce harm in those who eat it. Apparently the outside limit for vitamin D is far beyond the amount that the average person could take in an ordinary diet. Storage of the food does not cause destruction of the vitamin that is formed, except after periods of almost two years. Household cooking does not affect the activity.

By feeding commercially irradiated oatmeal, rickets was prevented in dogs and in rats and there was no interference in growth or in reproduction, as was shown in tests made on rats over a period of 15 months in four generations.

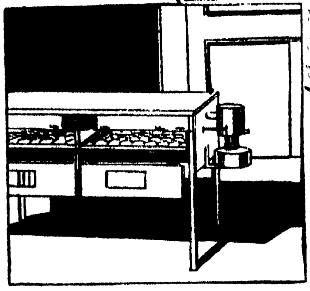
Soy Beans Versus Milk

IT is generally recognized that human milk is the best food for infants and that in the absence of human milk, the best substitute is cow's milk in some form, modified usually by the addition of various ingredients, such as sugar, water, or egg. There are, however, some diseases in infancy in which cow's milk is not desirable, and there are some infants who react severely to milk, breaking out with eruptions and developing symptoms like those of asthma. It is believed that some cases of severe eczema in infants are due to such sensitization.

In case an infant is unable to take cow's milk, it is necessary to have another sub-



For easily cleaned floors in poultry houses



For sturdy incubators

For signs and cut-outs

They

hatch 'em–raise 'em–sell 'em

with PRESDWOOD

In Racine, Wisconsin, a big manufacturer of incubators finds that Masonite Presdwood gives his product great strength, withstands moisture, is naturally attractive in appearance, and requires no paint for protection. On a Missouri farm, an expert poultry raiser uses this same grainless wood on hen house floors and under roosts, because of its smooth sanitary surface which is so easily cleaned.

Withstands the weather

In Kalamazoo, a sign manufacturer makes attractive cut-outs which advertise baby chicks, and finds Presdwood ideal for his purpose. It does not crack, split or splinter; is easily cut to shape. It withstands the weather, takes any finish readily, and does not warp when properly handled.

And so it goes in hundreds of industries and in thousands of home workshops where Presdwood has been adopted because of its many advantages.

Factory experts, operating punch presses, milling machines or band saws, like Presdwood for its workability. It is strong and dense, yet easily cut. It can be worked with knife or chisel or saw, and can be nailed near the edge without splitting. Always the same in strength and density, Presdwood adds quality and dependability to manufactured items. Makes manufacturing more profitable, too, because of the way this grainless wood cuts down costly rejections in final inspection.

Contractors, handling concrete work, use Presdwood to line the forms because of the thousands of dollars it saves. Its lighter weight cuts down drayage costs. Its workability reduces the time of making, erecting and wrecking the forms. Its perfect smooth surface eliminates all grain and knot marks, and produces a superior surface that requires no hand smoothing except at construction joints.

Masonite Structural Insulation

Presdwood's companion product, Masonite Structural Insulation, was used in the walls and roof of the hen house above illustrated.

It was used to save fuel, to reduce the feed needed in the generation of body heat, to keep the hens warm and healthy in order that egg production might be kept at a maximum during the winter.

The Presdwood booklet is Free

No wonder builders, home owners and manufacturers everywhere are turning to Presdwood. The complete story of this grainless wood, with illustrations of its uses, is in the Presdwood booklet which is sent Free on request. Your copy will be mailed promptly on receipt of the coupon.

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111 West Washington Street Chicago, Illinois

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City.......... *State*..........
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MASONITE STRUCTURAL INSULATION

stitute for human milk. In an attempt to find such a mixture, Drs. L. W. Hill and H. C. Stuart of Boston have experimented with a preparation of the soy bean. This has been used in one form or another in China as a supplementary infant food for many years. Using a soy bean flour as the basis of a preparation, Doctor Hill found that infants sensitive to cow's milk can be kept in a good state of nutrition by a preparation containing soy bean, calcium carbonate, and salt. The soy bean flour already contains some magnesium, potassium, and phosphorous. In order to raise the amount of fat, olive oil was added to the mixture.

Device for Determining Hemoglobin

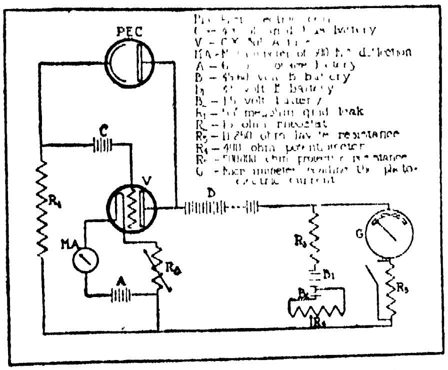
THE hemoglobin or red coloring matter of the blood is one of the most important substances in the human body, since it is responsible for carrying oxygen throughout the system to the various tissues. There are innumerable rough methods for determining the amount of hemoglobin that is present in the blood at various times. Few people are able to show what is called "100 percent", although florid types and people with certain diseases may show extremely high figures. The vast majority of people in good health show figures around 85 to 95 percent. In certain forms of anemia and jaundice, the hemoglobin may drop to low figures, and newspapers are likely to say that "the blood has turned to water".

Workers in the Mayo Clinic have developed an exceedingly ingenuous apparatus for measuring the amount of hemoglobin by a photo-electric method, involving the use of a photo-electric cell illuminated by a scource of light which is kept constant, providing readings on a galvanometer. When a solution of a substance which contains a characteristic absorption band is placed between the source of illumination and the photo-electric cell, together with a selective spectral filter which transmits radiant energy in the region of the characteristic band, the amount of light which reaches the photo-electric cell will depend on the concentration of the substance in solution possessing the specified absorption band. By calculating according to certain definite physical laws, it is possible in this way to measure accurately the amount of hemoglobin in any specimen of blood.

Another advantage of this method is its applicability to the determination of the amount of various unknown substances in true or colloidal solutions, provided the unknown substance in solution possesses at least one characteristic absorption band for which a spectral filter, transmitting radiant energy only in the specified region, can be made and used in the device.

The Heart of Pharaoh

THE Book of Exodus said, "And the Lord hardened the heart of Pharaoh," and that he did not listen to those who tried to counsel him to pity. Investigators in Egypt removed the wrappings of the mummy of this Pharaoh on July 8, 1907. The identity of the monarch was proved by the writings on the shroud. When the body was examined, it was found that there were patches of actual hardening in the heart and in the large blood vessels leading from the heart. A portion of the tissue was sent to the pathologic museum of the Royal College of Surgeons in England and Mr. S. G. Shattock compared the tissues with those of a man recently dead from hardening of the arteries. They were quite similar. It is possible to infer from the nature of the degenerative changes, that as Pharaoh became older his outlook was narrowed, his spirits depressed, his enthusiasm lessened, and that he would be likely to hesitate to embark on any new venture.



Diagrammatic sketch showing the electrical hookup of the photo-electrometer. In the upper right-hand corner is a list of the component parts, together with the key letters used in the diagram. An ordinary radio vacuum tube is used as the amplifier

The Extent of Illness

ONE of the first reports of the Committee on the Cost of Medical Care, which is making a five-year survey of disease in the United States and the manner in which it is controlled by the medical profession, indicates that the vast majority of time lost from work is due to the common cold and other respiratory diseases. Digestive diseases and similar disorders follow, and women suffer greatly with disturbances associated with their particular physiology. Acute and chronic diseases of the kidney and diseases associated with childbirth are also exceedingly frequent. The United States still has 36,000 cases of smallpox every year, an utterly inexcusable condition, in view of the fact that this disease could be stamped out completely if an enlightened public opinion should force general vaccination and isolation and quarantine of all cases.

There are approximately 900,000 feeble-minded imbeciles and idiots, 100,000 blind, 1,000,000 with speech defects, and 3,000,000 children either wholly or partially deaf.

The United States has more physicians proportionate to the population than any other nation of the world. Our hospitals have increased more rapidly in number and equipment than those of any other nation. Approximately 1,000,000 people are ill every day and about 700,000 are in hospitals.

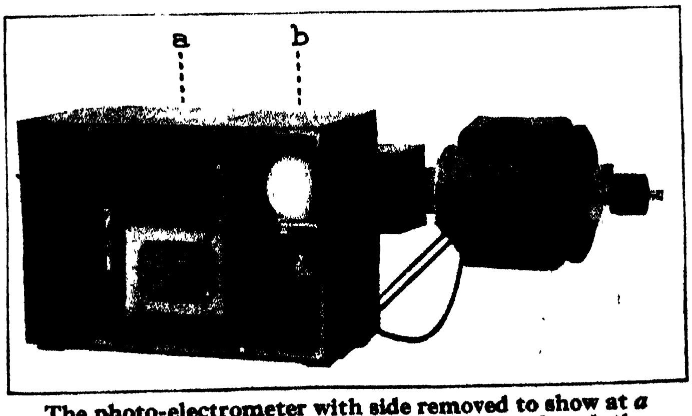
The problem of disease is one of the most serious of all of the considerations that affect mankind, and it is not surprising that its investigation should be attracting the greatest brains and the largest outlay of funds that are provided by the great foundations developed for the social welfare of man.

Anaphylaxis

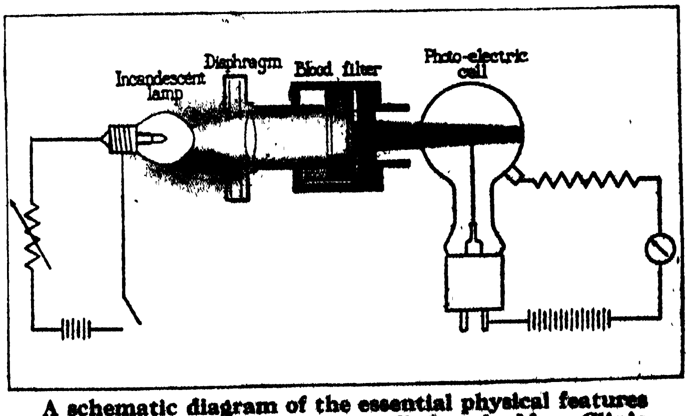
THERE is something in the human and animal body that causes it to become sensitized to various protein substances and to react to these substances by a series of symptoms which may be sufficiently severe to produce sudden death. This reactability is known as anaphylaxis and the exact mechanism is not yet wholly understood. Recently Dr. R. W. Lamson has again surveyed the subject in an endeavor to find out just what produces the symptoms.

When a guinea-pig is injected with a serum and is re-injected with the same serum about three weeks later, it manifests anaphylaxis by a sudden shortness of breath, primarily due to its inability to empty the lungs. Human beings become sensitized to various protein substances by heredity, through overdoses, through injection, or in various other ways. There are people who are sensitive to light, to heat, and to cold.

All of this indicates how scientific medicine is beginning to understand the nature of the human body, but also what a vast amount still remains to be learned concerning the specific mechanical and physical reactions of the tissues.

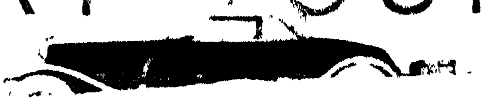


The photo-electrometer with side removed to show at *a* the vacuum tube used for the amplifier, and at *b* the photo-electric cell in position. See above text, at left



A schematic diagram of the essential physical features of the photo-electrometer as applied at the Mayo Clinic to the measurement of hemoglobin of the blood

CARS THAT STAY YOUNG



Look for car beauty, of course, but also make sure of the extra thousands of trouble-free miles that come with a "Timken Bearing Equipped" car.

Consult the list—note where the Timken Bearings are—give thought to the hard service points that need this extra protection and safety—that is the way to measure car worth in terms of continued youth.

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Cadillac	All					x
Chrysler	De Soto	x	x	x		x
	Plymouth	x	x	x		x
	66, 70, 77	x	x	x		x
	Imperial	x				x
Cord	All	x	x		x	x
Cunningham	All	x	x	x		x
Dodge	All	x	x			x
Durant	40, 60, 65, 66	x	x	x		
	70	x	x	x		x
Elcar	75	x	x	x		x
	95, 90, 120	x	x			x
Ford	All	x		x	x	x
Franklin	All	x	x	x	x	x
Gardner	All	x	x	x		x
Graham-Paige	612	x	x	x	x	x
	615	x	x			x
	621, 827, 837	x	x		x	x
Henney	All	x	x	x		x
Hudson and Essex	All	x	x	x		x
Hupmobile	Model S	x	x	x	x	x
	Model C	x	x	x	x	x
Jordan	All	x	x	x		x
Kissel	75 & 95	x	x	x		x
	126	x	x	x	x	x
Kleiber		x	x	x		x
LaSalle	All					x
Lincoln	All	x	x	x	x	x
Locomobile	86 & 88	x	x			x
Marmon	68	x				x
	78		x			x
	Roosevelt	x	x	x		x
McFarlan	All	x	x	x		x
Moon	All	x	x	x		x
Nash	Std 6	x	x	x	x	x
———	All	x	x		x	x
Peerless	All	x	x			x
Pierce-Arrow	All	x	x	x	x	x
Reo Flying Cloud	The Master	x	x		x	x
	Flying Cloud	x	x			x
Roamer		x	x	x		x
Stearns-Knight	6-80	x	x	x	x	x
	8-90	x	x	x	x	x
Studebaker and Erskine	All	x	x	x	x	x
Stutz	All	x	x	x		x
Willys-Knight and Whippet	All	x	x	x	x	x

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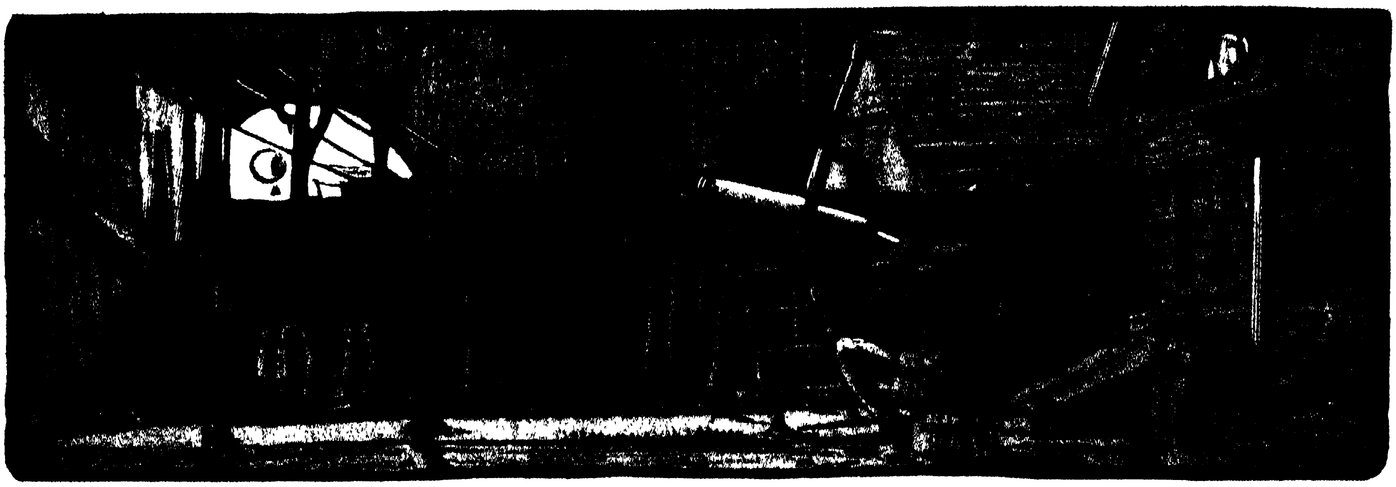
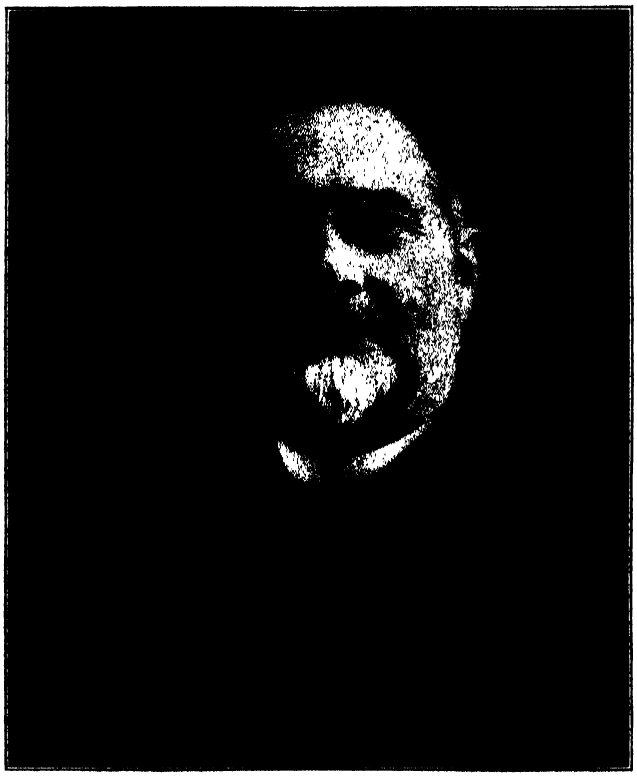


The Amateur Astronomer

MEMBERS of the amateur telescope making fraternity—the "C. P. R" (carborundum, pitch, and rouge) as Ellison our original preceptor once dubbed us—will take keen interest in the photograph reproduced at the right. This is a perfect likeness of Ellison. It is suggested that amateurs paste this picture in their copy of "Amateur Telescope Making." Had it been at hand when the new edition of that instruction book was in preparation it would surely have been included within the volume, which was originally built around Ellison's book, "The Amateur's Telescope" as a nucleus.



The Reverend Mr. William F. A. Ellison, telescope maker, Director of Armagh Observatory, Armagh, Northern Ireland

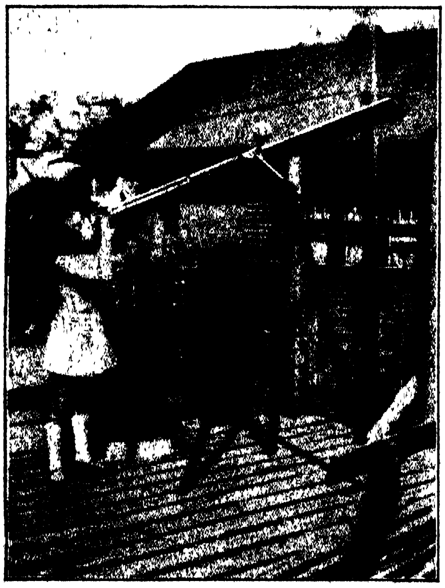
NOTHING but refractors are shown this month. So far as is known, these are all of the refractors that have been made since Ellison's unequalled instructions were included in "A. T.M." It is possible to make a refractor (of a sort) without due attention to the calculation of curves and care with other details; in fact many have been made from second-hand lenses previously used for other purposes. Henry Kawecki of Chicago (no street address submitted), a high school student, has made the one shown at left, using as the objective what he describes as "a lens which was once a mirror of plano-convex type from which the silver and paint were removed." The tube is three lengths of four-inch stove pipe and the eyepiece was taken from a microscope. Despite what some might regard as a doubtful type of objective, the maker states that he sees clearly Saturn's rings and Jupiter's moons, using 125 diameters magnification. "The chromatic aberration," he writes, "is not as bad as may be expected." He is now making a reflector.

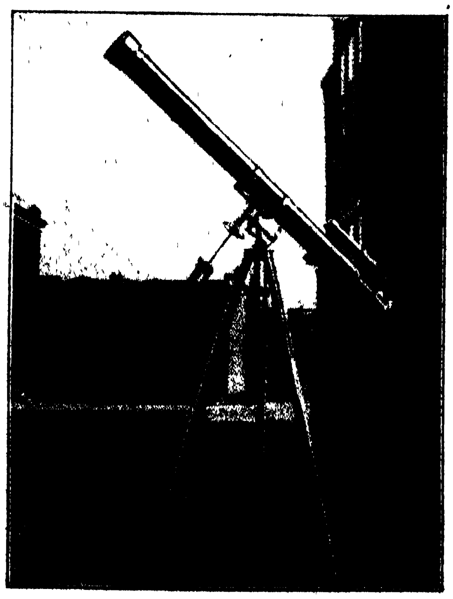
Fred Caley, 5122 Hawthorne Street, Frankford, Pennsylvania, writes: "I enclose a photo of a refractor I recently constructed, thinking it might be of interest to the ever-increasing army of telescope makers. I used the second formula given in 'A.T.M.' viz., three equal curves and a plane surface. Ellison states, 'The only snag is the plane surface.' I *heartily corroborate* his statement. The objective is 5¼ inches clear aperture and has a 76-inch focal length.

"The telescope is equipped with a worm gear, universal joint, and extension rod that can be worked without taking the eye from the ocular. Setting circles and a diagonal eyepiece are also fitted. Total cost, not more than 70 dollars.

"I previously ground and figured an eight-inch reflector which gave very satisfactory results. I also made a 5¼-inch flat and a couple of prisms, in order to gain experience. The refractor turned out much better than I expected."

Mr. Caley has obviously gone at this job right: after suitable preparatory experience of a prac-





Left: **Mr. Kawecki's synthetic refractor, and (*right*) the 5¼-inch refractor made by Mr. Caley, from Ellison's instructions**

Franklin W. Smith's refractor

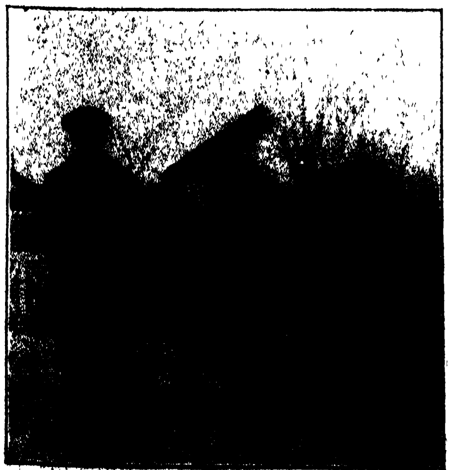
tical nature—making mirrors, prisms and flats, all of which enlarges one's resourcefulness in optical work—he has tackled the more difficult objective lens job and succeeded.

A SIMILAR approach to the objective lens has been made by Franklin W. Smith, 407 Scott Avenue, Glen Olden, Pennsylvania, whose telescope is shown in the illustration reproduced above.

"After finishing my first reflecting telescope, which was described in your January, 1927, issue, I have made several small reflectors, and have recently completed a refractor," Mr. Smith writes. "The achromatic objective has an aperture of three inches and a focal length of 60 inches. Great care was taken while polishing the convex surfaces of the crown glass to prevent wearing down the centers excessively; in this way, positive spherical aberration was avoided, and it was therefore possible to finish the figuring, which was controlled by Ellison's ingenious 'auto-collimation test,' quickly and without difficulty.

"The color correction and defining power of the telescope seem satisfactory; double stars such as *alpha Geminorum, gamma Virginis,* and *gamma Leonis* are readily separated, even under the rather poor conditions of seeing which prevail here at certain times of the year.

"Although it takes vastly more time and labor to make a refractor than to make a reflector of the same aperture, the actual work is really no more difficult, assuming, of course, that the worker has had sufficient



George E. Stephenson and refractor

A Strand of Yellow

Aerial Wire Rope Tramways of Broderick & Bascom design are saving time and money for mines and industrial plants all over this country, in Mexico and Alaska. Investigate.

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Manufacturers of nothing but wire rope for over half a century

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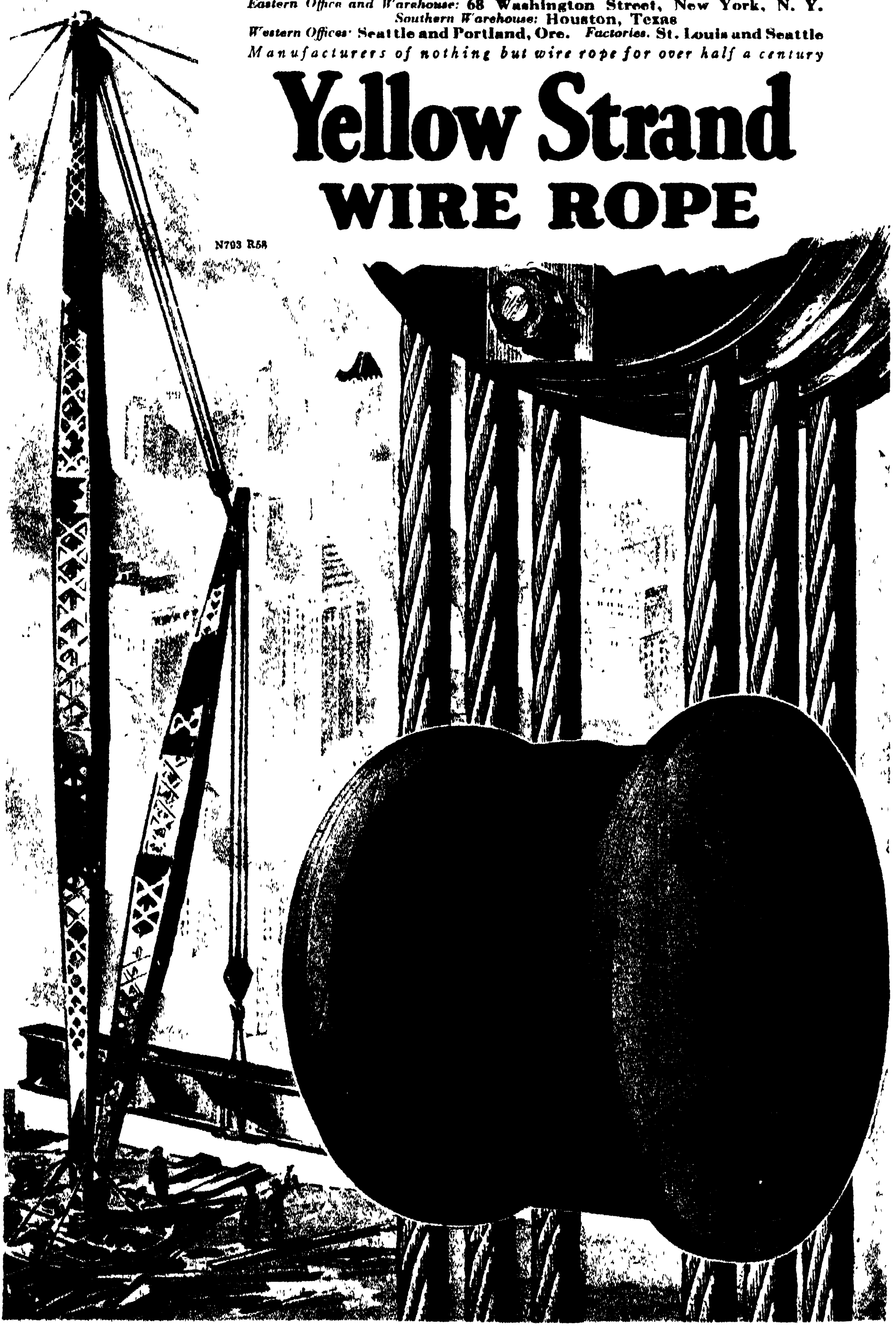

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experience to enable him readily to produce a zone-free optical surface. I found that it required over four times as much work to make the three-inch refractor as to make a five-inch reflector. Not only are there four surfaces to work instead of one, but at least three of the four curves are much deeper than the single curve of the reflector. While rough grinding I soon came to the conclusion that the use of metal tools previously turned on the lathe to the proper radii would be a much more economical means of producing the deep curves necessary, since a glass tool grinds the edges as well as the center of a concave surface and the center as well as the edge of a convex, and much labor is needlessly expended.

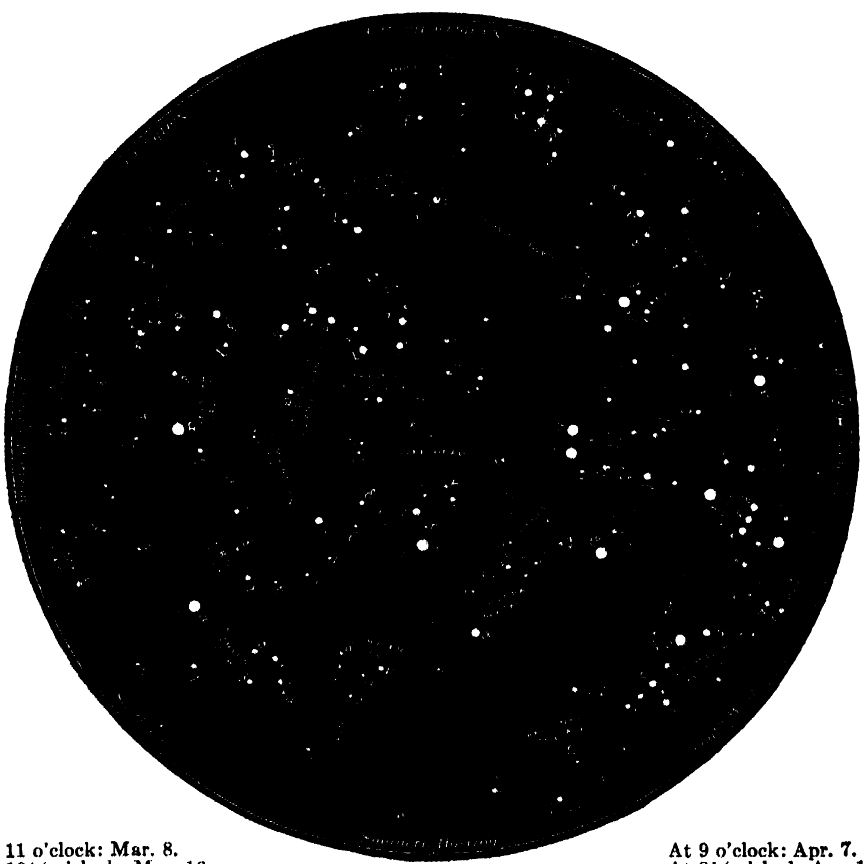
"The auto-collimation test is as simple to apply as the ordinary mirror test, assuming of course that a flat the size of the lens is available. I prepared the flat by the method given on page 87 of 'Amateur Telescope Making.'

"Since completing the three-inch refractor, I have been using it for observing variable stars. Under ordinary conditions of seeing it will show stars slightly fainter than magnitude 11. In this locality, the theoretical limit of a telescope can be reached on exceptionally good nights only. At least that has been my experience with the 10-inch Clark refractor of the Haverford College Observatory."

The fourth refractor shown is apparently one of the synthetic type. The photograph reached us without accompanying letter and bore on its back only the name of the sender, Mr. George E. Stephenson, Roosevelt Avenue, Roosevelt, Long Island.—*A.G.I., Tel. Ed.*

The Heavens in March

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.

At 9½ o'clock: March 29.

At 9 o'clock: Apr. 7.
At 8½ o'clock: Apr. 14.
At 8 o'clock: Apr. 22.

NIGHT SKY: MARCH AND APRIL

MERCURY is a morning star, rising a little before 6 A.M. during the early part of the month, but lost to the sunlight long before its close. Venus is an evening star and is coming out gradually from the twilight. By the end of the month she sets at 7.10 P.M. and is fairly conspicuous. Mars is a morning star rising between 5 and 5:30 A.M. and is still far off and faint. On the first he is in conjunction with Mercury, the two planets being only half a degree apart. Jupiter is an evening star in Taurus, but is so far north that he remains in sight until after midnight. Saturn is a morning star, rising at 2:40 A.M. on the 15th, and can be observed before daybreak, though only at a low altitude. Uranus is an evening star too low in the west to be easily observed, but Neptune is just past opposition and is visible telescopically almost all night. On March 15th its R. A. will be 10h 16m, and its Decl. 11° 31′ N.

The moon is in her first quarter at 11 P.M. on the 7th; full at 2 P.M. on the 14th; in her last quarter at 10 P.M. on the 21st; and new at 1 A.M. on the 30th. She is nearest the earth on the 12th and remotest on the 24th. As she completes her orbit she passes through conjunction with Uranus on the 2nd, Jupiter on the 7th, Neptune on the 13th, Saturn on the 22nd, Mars on the 27th, Mercury on the 29th, Uranus again on the 30th, and Venus on the 31st.

Chemistry in Industry

(*Continued from page 237*)

preciably beyond a certain thickness, as is shown by the test of a piece of aluminum foil 0.001 inches thick:

Time, Minutes	Thickness, Inches
15	0.0017
30	0.0018
60	0.0020
240	0.0024

Upon analysis, the coating on a ¼-mil foil was found to consist of Al_2O_3, 54.5 percent; CaO, 5.75 percent; SO_3, 10.7 percent; and water expelled at 300 degrees, centigrade, 29 percent. The coating is always hydrated as formed, but the water may be removed by baking at 300 degrees, centigrade.

Edible Oil from Nut Shells

PECAN oil, described by chemists of the United States Department of Agriculture as of very mild, agreeable, and characteristic flavor, is one of the latest additions to the long list of products manufactured from what were formerly farm wastes.

Fine nut fragments accumulate at the pecan-shelling plants. Chemists have made experimental pressings of this waste and determined the properties and composition of the oil, which is of excellent quality and can be used for making salad dressings or other edible products. It is necessary to express the oil before the nut waste becomes rancid, as otherwise the oil would not be edible.

Fuel Gas From Farm Waste

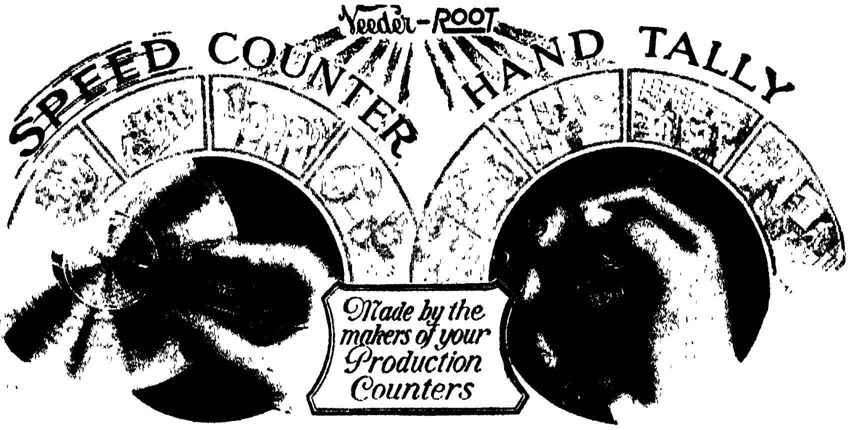
CORNSTALK gas to light and heat cities was announced recently by the American Chemical Society. Ordinary sewage and plain cornstalks are allowed to decompose, forming the gas. From these two wastes, University of Illinois chemists are recovering large quantities of methane gas, usable for heating, operating autos in place of gasoline, and driving generators producing electricity. They also are recovering carbon dioxide which they propose to utilize by converting it into "dry ice."

The chemists believe they have an apparatus so simple that it can be installed by the farmer to make his family sewage turn his cornstalks into cheap cooking gas. It requires no machinery; bacteria from sewage do the necessary work.

The author of the discovery is Dr. A. M. Buswell, Professor of Sanitary Chemistry at Illinois, assisted by C. S. Boruff. Dr. Buswell said "The material used is dried cornstalks after husking. The stalks are shredded with an ordinary shredding machine, boiled, soaked in water or soaked in lime.

"The apparatus is simply a small tank provided with a cover to collect gases. A farmer could produce enough gas to supply the needs of a family of four or five from the material which could be fermented from a gas tank eight feet in diameter and eight feet deep."

The authors estimated that a circle of corn land eight miles in diameter would produce enough cornstalks to meet the usual gas consumption of a city of 80,000.



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Our Point of View

Our Limitation Conference Delegates

(*Continued from page* 189)

1928, and is the natural successor to Lowden as the representative of the mid-west agrarian movement. Mr. Dawes has a certain impatience for detail, and a small tendency to picturesque but inexact phraseology that somewhat impairs his large abilities. As ambassador to The Court of St. James, he plunged boldly into European diplomacy with which he had had no previous experience, depending entirely upon his good intentions and his native ability; even his short experience at London must have taught him that international relations cannot be hastily adjusted nor treaties between great states compressed into friendly epigrams.

Mr. Hugh Gibson, American Minister to Belgium, one of the youngest members of the delegation, a Californian by birth, graduated from the Ecole Libre des Sciences Politiques, Paris, and began his career in the diplomatic service in 1908. He served as Secretary of Legation at Brussels from 1914 until our entrance into the World War. During the trying days of German occupation of Belgium he was Brand Whitlock's trusted assistant and greatly assisted Mr. Hoover in his work of Belgian relief. In company with the Spanish Ambassador, he made the final useless appeal to the German Governor General to reprieve Edith Cavell.

He showed conspicuous ability as Chairman of the American Delegation to the Conference for Limitation of Naval Armament in 1927, in resisting British claims to a superiority in cruiser strength over our own navy. If the British public harbors any resentment to Mr. Gibson on this account it should recall that he as fearlessly faced the Germans in behalf of Nurse Cavell. Mr. Gibson brings to his task a fine mind ripened by long experience in world affairs. He knows too much of the horrors of war to be a militarist and knows too much of the ways of the world to weaken the defenses of his own country.

MR. Dwight Whitney Morrow comes from West Virginia, was educated at Amherst with ex-President Coolidge, studied law at Columbia and began the practice of law in New York City in 1899. He joined the firm of J. P. Morgan and Company in 1914 where he remained until he resigned to become Ambassador to Mexico in 1927; he found time from his business affairs to serve on numerous charitable and welfare boards.

Mr. Morrow has a talent for reconciling apparently irreconcilable ideas, and has shown great aptitude in finding a basis of agreement for people with divergent but not necessarily conflicting interests. He served during the war as Adviser to the Allied Maritime Transport Council.

He first attracted the nation's attention by his judicial conduct as Chairman of the President's Aircraft Board in 1925 when, under his guidance, the board thoroughly explored the aviation situation in our country and laid out the comprehensive program of aviation development that is rapidly placing our country in the forefront of world aviation.

In 1927 President Coolidge sent Mr.

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* * *

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Morrow to Mexico as Ambassador to that insurrection-torn country where he made an almost instantaneous appeal to her proud people and gained their respect and almost their affection. He is no miracle worker and would be the first to disclaim some of the complimentary statements made about his efforts in Mexico, but it can be said in all moderation that he has dispelled much of the prejudice against our country previously current in Mexico. The causes of unrest in Mexico are too deep-seated to be removed in two years and Mr. Morrow's reputation as Ambassador will be longer lived if his remarkable work is not exaggerated by over-zealous friends.

Mr. Morrow's long business experience, his broad outlook, and his veritable genius for conciliation fit him for his new task. His previous services have brought him the respect of his countrymen and it is fair prophecy that at London he will again serve them well.

MR. Charles Francis Adams, the great-great-grandson of John Adams, departed from Harvard in 1888 with his A. B. degree, but soon returned as Treasurer of the corporation, and the present flourishing state of Harvard's finances attest his business ability. He is better known to his countrymen perhaps as the amateur skipper who sailed the *Resolute* to victory in the international races of 1920. Since his appointment as Secretary of the Navy he has diligently applied his fine understanding to the problems of the Navy Department. His love for the sea formed an immediate bond between him and the navy personnel.

John Adams established the Navy Department in 1798; his son, John Quincy Adams, formulated the Monroe Doctrine which is only as strong as the United States Navy; Charles Francis Adams, the son of John Quincy, during our Civil War vigorously reminded the British Government of its obligations as a neutral state; and now Charles Francis Adams 2nd returns to London to present his country's reasons for a navy second to none. Certainly the spirits of his sea-minded ancestors will hover sympathetically over the latest member of the family to enter the lists as champion of his country's rights on the ocean.

Senator David Aiken Reed is a product of Princeton and the University of Pittsburgh. He commenced his career by practicing law in Pittsburgh in 1903. The World War interrupted his legal work and he went to France as a Major in the 311th Field Artillery. His service overseas earned him our own Distinguished Service Medal and caused the French Government to make him a Chevalier of the Legion of Honor.

Senator Reed for two years has been Pennsylvania's sole representative in the Upper House, and although a comparative new-comer, he has ably carried the added responsibility. He has an aggressive personality and when he raises his long form from his seat in the Senate the listener is sure to hear some unqualified statement. His Princeton training makes him abhor a solecism and amid the bustle of affairs he is not too busy to call the Senate's attention to the faulty construction of a sentence. He is a leading member of the Military Affairs Committee and has shown unusual interest in questions of national defense. His influence among his col-

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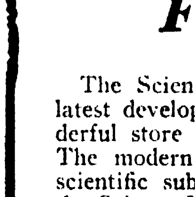

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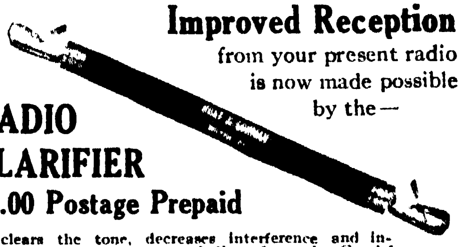

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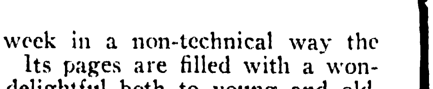

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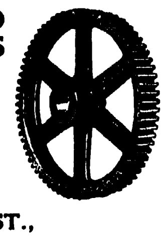

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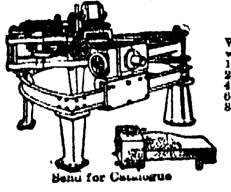

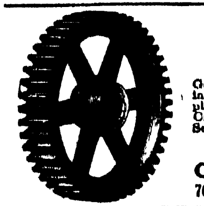

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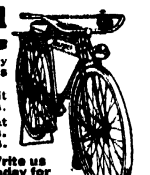

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leagues, both Republican and Democrat, will be of great assistance to President Hoover in getting the Senate's approval to a limitation pact.

Senator Joseph T. Robinson, Democratic leader in the Senate and Democratic candidate for Vice President in 1928, represented the 6th District of Arkansas in the House from 1903 to 1913; was elected Governor of Arkansas in January, 1913; and during the same month was sent by his state to the Senate where he still continues to serve.

Senator Robinson became generally known to his countrymen as a virile campaigner when he swung 'round the circle during the 1928 campaign. His selection as a delegate reminds the world that domestic politics in the United States ceases at the water's edge and assures the Democratic party that the Administration is not seeking to monopolize any prestige it may acquire in its conduct of foreign affairs.

If Senator Robinson approves of a naval pact he will be of much assistance to Mr. Hoover in getting it approved by the Senate; if he does not, as minority leader he can almost certainly prevent its acceptance by the Senate, so he wields a greater power than any other delegate.

REAR Admiral Hilary P. Jones, Retired, entered the navy as a Midshipman from Virginia in 1880. He has served in all the grades from Midshipman to Admiral, having commanded the United States Fleet with temporary rank of Admiral, 1921-1922. During the World War he commanded a division of the Cruiser and Transport Service. Despite his services on the active list as Vice Admiral and Admiral, in accordance with the provisions of an ungenerous naval law he retired as a Rear Admiral in 1927.

Rear Admiral Jones has been again recalled to active duty as a naval adviser largely because of his familiarity with the entire question of limitation of naval armament—he attended the 1927 Conference for Limitation of Naval Armament at Geneva, as a delegate. He brings to this problem a knowledge of naval matters and world affairs, and although he may be relied upon stoutly to defend American interests, he is no saber-rattling chauvinist and knows enough of war to prefer peace.

Admiral William V. Pratt, Commander-in-Chief of the United States Fleet, knows from the very latest fleet maneuvers the needs of our navy for cruisers. Like Admiral Jones, he has served in all the naval grades. During the World War he served as Assistant Chief of Naval Operations, and during Admiral Benson's inspection trip to Europe, Admiral Pratt acted as Chief of Naval Operations although only a Captain in rank. He had previously graduated from the War College and therefore brought to his position a theoretical knowledge of modern war that stood him in good stead. He acted in an advisory capacity to the American delegates in the Disarmament Conference of 1921 that scrapped American battleships.

Since the war he has been President of the Naval War College, Commander-in-Chief of the Battle Fleet, and is now Commander-in-Chief of the United States Fleet.

Rear Admiral William Adger Moffett, Chief of the Bureau of Aeronautics, has had many thrilling moments in the air but he probably got his greatest thrill on April 22, 1914, when he steamed into the inner

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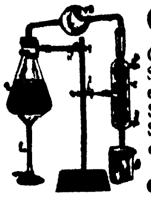

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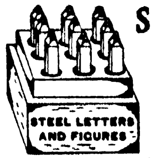

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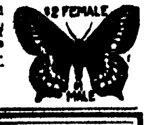

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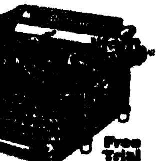

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harbor of Vera Cruz with the light cruiser *Chester* and by her destructive fire on the buildings sheltering Mexican snipers, opened the way for the American landing force. His prompt action and conspicuous initiative on that occasion saved the lives of many American sailors.

In an unusual sense, Admiral Moffett is Chief of Aeronautics, for the office was almost created for him and he has been the sole incumbent since its establishment in 1921. Caught on shore during the World War, he threw his enormous energy into the task of expanding the Great Lakes Training Station into the largest naval training station in the world. He accompanied Commander Lansdowne on the transcontinental flight of the *Shenandoah*, and is an enthusiastic believer in both heavier and lighter than air craft. His presence among the advisers should insure that the interests of naval aviation will not be forgotten in any limitation agreement.

Rear Admiral Joel P. R. Pringle is at present President of the Naval War College at Newport. During the World War he was Chief of Staff for the American destroyers based on Queenstown and as the senior American naval officer present at Queenstown, was in virtual command of the American forces serving at that important station.

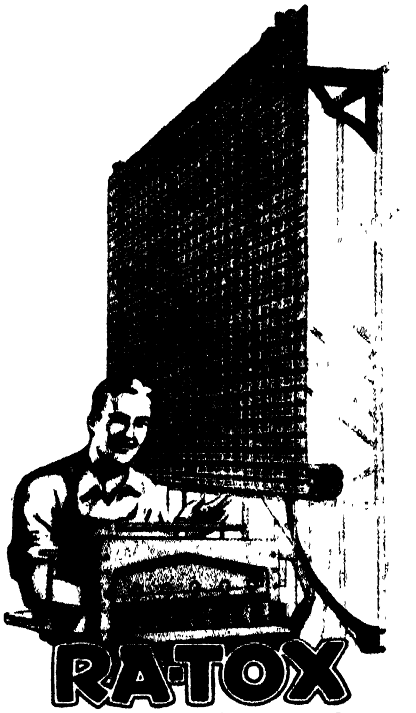
Admiral Pringle maintained most cordial relations with Admiral Sir Lewis Bayly, British Commander-in-Chief in Ireland, and in consequence there was a unity of action between British and American naval forces rarely found among allied forces. Since the war, Admiral Pringle has served at sea in command of the battleship *Idaho* and as Chief of Staff of the Battle Fleet.

Rear Admiral Harry E. Yarnell is Chief of the Bureau of Engineering and as such is intimately acquainted with the most recent developments in marine engineering. His knowledge will be most useful to the board in considering the relative values of cruisers.

During the World War he commanded the *Nashville*, but was soon summoned to London by Admiral Sims to serve on the War Plans Committee.

After the war he went into naval aviation and is still a qualified aviation observer. He commanded the Aircraft Squadrons, Scouting Fleet, in 1924-25, and in 1928 commissioned, and later commanded, our latest aircraft carrier, the *Saratoga*. He is a War College graduate and has also served on its staff, and as a member of the War Plans Division, in Naval Operations. Throughout his career, Rear Admiral Yarnell has been noted for his sound judgment.

REAR Admiral Arthur J. Hepburn is the youngest Admiral in the Navy. At present he is Chief of Staff for Admiral Pratt, Commander-in-Chief of the United States Fleet, and brings to the Conference a thorough knowledge of the operating needs of our fleet. During the World War he organized and commanded the American submarine chasers operating in Ireland, and subsequently served as Director of Naval Intelligence. His sea experience in the United States Fleet has been unusually extensive, for he commanded our largest superdreadnaught, the *West Virginia*, then served as Chief-of-Staff, Battleship Divisions and of the Battle Fleet, before becoming Chief-of-Staff, United States Fleet.



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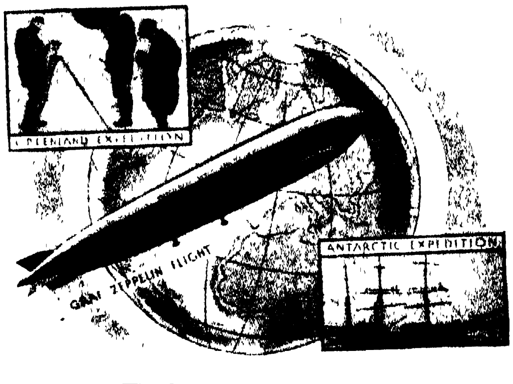

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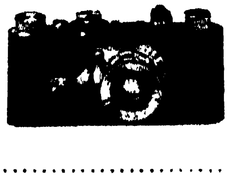

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Rights to Fruit Spray Removal Process Contested

RIGHTS to a process of vital interest to the fruit industry of the country, claimed by the Department of Agriculture and the California firm of Brogden and Trowbridge, are involved in litigation now pending in the Patent Office. According to the claims made by the Department of Agriculture, the process using a dilute solution of acids or alkalis in removal of spray residue from fruits and vegetables was conceived and put into practice by employees of the Department. However, application for patent submitted by the Department in the name of Arthur M. Henry, government chemist, was declared by the Patent Office to be in interference with the application of Brogden and Trowbridge.

The process has been extremely useful in preparing fruit for market, and has been in almost constant use in various fruit-producing regions since 1925. It has been stated publicly by the Department of Agriculture that if the Henry application is granted, it will be dedicated to the service of the public and may be used by anyone without royalty charges or other costs. Mr. Henry is a chemist of the Philadelphia station of the Food, Drug, and Insecticide Administration of the Department of Agriculture.

Copyright Denied Because of Disclosure in Patent

WHEN an inventor has applied for and obtained a patent on a certain model or relief diagram, he cannot extend his monopoly by taking out a copyright on what he has already diagramatically disclosed, according to the Circuit Court of Appeals for the Second Circuit. In the case of Alfred Korzybski *vs* Underwood and Underwood, Inc., it was found that Korzybski had made a full disclosure of his invention in his patent application. Later he sought to obtain a copyright on the design involved, with no substantial distinction between the disclosure of the patent and the design of the copyright, and no real question of merit of a particular design as compared with the drawings of the patent.

Quoting from Weil on copyrights, the Court said: "While in doubtful cases the Court will hold that presumably the fact that a given work is patentable is ground for holding it is not copyrightable and *vice versa*, it seems that there is no rule of law nor is there any consideration of public policy which will prevent the issuance of both a copyright and a patent to cover the same work in its different aspects in a proper case. . . . A novel household utensil may be modeled by a great sculptor. Its form may be artistic in the highest degree, its machinery may show the qualities necessary to patentability, its use may be purely utilitarian and it may be so constructed as to be one inseparable unit. In such event it should be both copyrightable and patentable."

However, it also was pointed out, such a situation does not arise on the facts of the present case, when there seems no room for distinction in design. Section seven of the copyright act provides: "That no copyright shall subsist in the original text of any work which is in the public domain." The defendant had done no more than photograph the device in question, which it had a full right to do, because the subject matter of the patent had become public property.

Patent Sustained for Combination of Pantograph and Blow Torch

DECIDING on the validity of the Worthy C. Bucknam patent (Number 1059329) covering the combination of a cutting torch with a pantograph by which the torch is guided, the District Court for the Northern District of Ohio has ruled the Bucknam claims valid and infringed. The case in suit was instituted by the Air Reduction Company, Inc., against the White Tool and Supply Company. In the decision of the Court, it was noted that the patentability of the combination was substantiated by the fact that the devices of the plaintiff based on this invention have gone into wide use, supplanting earlier devices and methods.

In the description of the invention, the Court said: "Bucknam devised a pantograph frame pivoted to a post at one corner of the parallelogram; one of the arms carried a torch or blow pipe with the nozzle pointed down to the surface of the metal to be cut; and to the end of an extension of another of the arms was attached a swiveled roll tracer, which, being set in motion either by hand crank or electric motor, traveled over the lines of any pattern or blue print that might be put under it, and so moving, caused the torch to move with precision and regularity over the same course, and cut the metal cleanly, with astonishing accuracy, and exactly in conformity to the pattern."

The prior art had associated the pantograph with various devices, such as a pyrograph for burning designs on wood, sewing machines for placing stitches in designs on cloth, and electric welding apparatus. However, the Court held, it was new and patentable to combine a pantograph with an oxygen blow torch for cutting metal along various lines to leave a smooth edge. The arts are so remote, and the construction so different and altered, that invention was involved in the transposition, mere double use not being involved.

It also was held by the Court, with respect to the defense of double patent, that where two patents issue the same day, there is no presumption that the lower number is the prior patent. In such instances the higher number will not be held void for double patenting even if the lower number accidentally contains a claim similar to those of the higher number. This notation referred to Patent Number 1059271, issued the same day as the other Bucknam patent noted above. In the trial, the plaintiff relied solely on certain claims of Patent Number 1059329, covering, in effect, the same invention.

Courtesy Air Reduction Sales Company

Cutting a locomotive side rod with an oxygraph, one of the numerous industrial applications of W. C. Bucknam's combined pantograph and blow torch

By means of the pantograph attachment, cutting by means of a blow torch has been improved materially. This apparatus has gone into widespread commercial use, to meet the need for cutting shapes from steel plates and billets according to drawings or templates. Large and small devices based on this principle are made and sold by the plaintiff, holder of the Bucknam patents and others of similar nature.

This apparatus, in both sizes, consists of an oxy-acetylene cutting torch mechanically supported on a pantograph, actuated by a tracing wheel driven by a small electric motor. The tracing wheel may be guided by hand over the lines of a drawing, or it can be guided automatically by means of a metal template. Metal up to 20 inches in thickness is cut by this means into any desired shape or design. In the smaller apparatus, the torch operates on a one-to-two ratio with the tracing wheel, following the movements of the tracer on a reduced scale. The larger apparatus cuts an exact reproduction of the path traversed by the tracing wheel, thus producing the large cutting area necessary for locomotive, forge, boiler, tank, and heavy machine-shop work.

Advertisement Admitted as Evidence

WHILE advertisement is not proof of trademark use, it is evidence of contemplated use and is entitled to weight with other testimony of use, in the opinion of the First Assistant Commissioner of Patents. This decision was made in ruling that the trademark "Primfit" is deceptively similar to "Trimfit," both marks being used as designations for hosiery.

Considering it obvious that the marks were so similar in sound and appearance as to cause confusion if both products were to appear in the same market, the only point to be decided was whether the holder of the first registered mark, "Trimfit," had proved prior adoption and use. Unsigned copies of typewritten statements, not properly identified, were not considered proper evidence showing that the mark was in use. No explanation was offered as to why the originals were not produced.

A page said to be a copy of an advertisement of his firm was offered by the witness, showing that in the February 1923 edition of the *Hosiery Retailer* use had been made of the "Trimfit" trademark for advertising purposes. The Commissioner held it obvious that the company would not insert in a publication an advertisement of that type unless the company were intending or in a position to offer its goods under the trademark. Additional proof of prior use of the mark was presented in testimony showing orders for labels and their printing and delivery with copies of orders, and samples of hosiery bearing the trademark. The conflicting mark was ordered cancelled.

Contributory Infringement of Process Patents

THE Circuit Court of Appeals for the Second Circuit, in Novadel Process Corporation *vs* J. P. Meyer and Company, has recently decided an interesting case involving the infringement of a process patent by one who sells the ingredients for use by the purchaser in performing a process of bleaching flour. The patent sued on was what is known as a "process patent," that is to say, one covering a step or a series of steps whereby materials and things are changed either physically or in their chemical characteristics, producing a new article of manufacture.

The particular process involved in the suit consisted in adding certain chemicals to flour for the purpose of bleaching the flour. No one can infringe such a patent who does not actually perform the process or assist another in performing it. A process for manufacturing soap or preserves, or for bleaching flour would not be infringed by one who sold soap, preserves, and flour prepared and treated by a patented process if the seller had not actually performed the process whereby the products were produced.

In this case, both parties sold under certain trademarks the chemicals which when added to flour constituted the patented process. The owner of the process patent not only had the right to carry out the process of bleaching flour, but also the right to sell the required chemicals to millers to enable them to carry out the bleaching process.

While the infringer does not appear to have been engaged in performing the bleaching process, the Court ruled it nevertheless sold to millers the necessary chemicals—substantially those chemicals employed in the patented process. In so doing, the defendant knew that the millers were to use the chemicals in bleaching flour, and intended and directed that the chemicals should be so used, instructing the millers how to use them.

The millers, using the chemicals purchased from the defendant, performed the patented process and thereby infringed the plaintiff's patent. As the defendant had instigated such infringing acts, even though it had not itself performed the infringing process, the court held that it was a contributory infringer. The defendant was enjoined from selling its chemicals when knowing that they would be used in a process which infringed the plaintiff's patent.

Infringement of Registered Trademark in Foreign Commerce

A RATHER unusual infringement case has been decided by the Court of Appeals for the Second Circuit. The suit was instituted by Hecker H-O Company, Inc., against Holland Food Corporation. The defendant had made no sales apparently, in the United States, but it purchased cereal products in this country from various manufacturers, packing the products in packages, boxes, and barrels, and applying thereto the trademark "Hofood." The goods were shipped from American ports to foreign countries, including England, Holland, Belgium, Switzerland, and Greece, where they were sold. Although no sales had been made in the United States, where plaintiff's registration was in force, the court nevertheless held that "labeling packages, boxes, and barrels with the mark 'Hofood' and sending them into foreign commerce for sale in foreign countries was a violation of the trademark act."

The defendant raised the question as to whether, if the labels showing the infringing trademark were affixed in foreign countries where its product was sold, it would constitute an infringement and violate the provisions of the trademark act. The court declined to decide that question, on the ground that it was sufficient, for the disposition of the present case, to hold that the act of the defendant in affixing its infringing mark in this country was a violation of the act.

In a similar case, tried in the District Court in the Southern District of New York some years ago, the court held it to be an infringement to place an infringing trademark on certain textile fabrics in this country and ship them to Turkey for sale. In that case there was ample proof that the owner of the trademark had established a large business in Turkey for exactly the kind of fabric on which the defendant had placed the infringing mark. The defendant was held to have infringed not only by applying the mark in this country but by selling the merchandise in the plaintiff's market in a foreign country, and was enjoined and forced to pay damages as well as the costs of the suit.

Patents Recently Issued

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Pertaining to Aeronautics

Wing - Structure - Varying Device for Aeroplanes—Whereby the wing structure, and the curvature of the profile of the wings, may be changed from a monoplane to a biplane, for varying the amplitude of the lifting surface, at the will of the pilot, even during flight. Patent 1738463. Aldo Tammeo.

Pertaining to Apparel

Corset—Of substantially conventional type, having elastic side sections, but having a normally permanently positioned section at the front, which may be removed, and a plurality of fastening means adjustable to take up stretching of the various parts. Patent 1738434. Joseph J. Kispert.

Shawl Coat—For children, formed from a one-piece rectangular fabric folded together and secured so that it will remain in position to act as sleeves, a body and a muffler, without cutting or materially creasing the garment. Patent 1739433. Helen B. Young.

Glove and Method of Making the Same—A glove of the slip-on or gauntlet type, having an opening at the side and an integral inwardly turned hem joined to a finishing strip in such manner as to provide an attractive appearance, with strength and durability in use. Patent 1740218. Schuyler E. Benjamin and Wendell P. Murray.

Binding—Especially adapted for gloves, being composed of superimposed flexible strips of contrasting colors, the outer of said strips having longitudinal perforations to enable the double thickness to follow the contour of the binding edge. Patent 1742117. Albert Aaron and Schuyler Benjamin.

Designs

Design for a Doll or Similar Article—Patent 80080. Adolph Gramlich.

Design for a Toy Glider—Patent 79978. Andrew A. O'Brien.

Designs for Radiator Ornaments—The inventor has been granted three patents for ornamental figures for vehicle radiators. Patents 80122, 80123 and 80124. Biagio Intingaro.

Design for a Coat—Patent 80132. Dorothy Long.

Designs for Dresses—The inventor has been granted three patents on designs for dresses. 80131, 80133 and 80134. Dorothy Long.

Design for a Combination Curtain Pole, Curtain-Rod Bracket and Suspending Means—Patent 80184. Bror G. Norberg.

Electrical Devices

Automatic Circuit Closer for Electric Signal Lights and Signs—Of the disk type flasher, intended for use in alternately changing colored lights at definite intervals to suit the needs of traffic, or may be used for other signaling requirements. Patent 1738444. William E. Nagem.

Circuit Breaker—For the ignition and lighting circuits of a motor vehicle when its motor ceases operation, so that in parking, should the operator fail to turn off, the device will automatically disrupt their circuits and prevent injury to the battery. Patent 1737961. Frank P. Ellis.

Vacuum Tube—An electrode support comprising an annular body having layers of insulating materials of different dielectric strengths and permittivities in such manner that the permittivity of the layers descreases in value inversely with the distance from the electrode. Patent 1739513. Ralph W. Lohman.

Electric Defroster for Refrigerating Coils—Whereby electric heat will be automatically applied to the cooling units of a refrigerating plant at predetermined intervals, and the accumulation of any appreciable amount of frost on said units will be prevented. Patent 1742062. William B. Day.

Of General Interest

Holding Device for Ironing-Board Covers—By means of which a cloth or other form of covering can be securely held in a taut condition thus presenting a smooth surface for ironing operations, the device is adjustable to boards of various widths. Patent 1737300. Joseph H. Dayton.

Weather Strip -Composed mainly of metal and having a rubber or flexible portion, may be cut to fit any window-frame or casement and attached by merely pressing the strip into its support, will be absolutely weathertight. Patent 1738350. Frank B. Buckhout.

Follower for Filing-Cabinet Drawers—For holding filed articles in a substantially upright position in the drawer, the bottom being equipped with longitudinally spaced keepers, the followers having dentent means engaging with the keepers to lock the followers against movement. Patent 1738419. Alexander Burger.

Valve—Of the quick-acting type, employed on boiler blow-off lines, on lines carrying viscous fluids or gritty matter, which will be tight when closed, and have a free waterway, equal to the size of the pipe. Patent 1738450. Edward F. Ryan and Edward T. Adams.

Cable Guard—Adapted to be secured to a post by a simple means, which also serves to connect a pair of similarly formed sections, said sections having slotted flanges which overlap to receive and support the cable. Patent 1738447. Irving E. Quist.

Lighter—Such as are commonly known as cigar or cigarette lighters, in which the lighter mechanism is movable relatively to the container, so as to either enclose the lighter or project it in position for use. Patent 1738451. Karl Schreer.

Whistle Cup—So constructed as to induce a small child to drink the milk or other contents of the cup in order to blow the whistle, which can only be operated when the cup is empty. Patent 1739451. Clarence B. Fowler.

Method of Flowing Oil—By introducing a current of heat around the perforated tubing at the well bottom, to break down the heavier constituents and reduce the viscosity of the oil thus accelerating its flow from the well. Patent 1737894. Edward P. Reynolds.

Disappearing Picture Illuminator—By virtue of which a lamp and reflector may be instantaneously moved from a concealed inactive position at the rear of the picture to an exposed projecting position for flood-lighting the picture face. Patent 1739320. Herbert D. Lloyd.

Fountain Pen—So constructed that the filling operation is very much simplified, permitting any required amount of ink to be drawn into the barrel and the pen filled with facility. Patent 1739235. Thomas Pearson.

Spout—For dispensing devices, which may be readily moved from an active to an inactive position for forming a closure, is particularly adapted for use with syrups served on a table, the receptacle being kept clean on the outside. Patent 1738077. Thorvald Petersen.

Toothbrush—Embodying a flexible brush element, which is readily removable from the holder, and may be spread apart so that its entire surface may be cleansed, thus preventing bacteria lodging between the bristles. Patent 1739324. William M. Neissl.

Bottle Stopper—Which may be readily manipulated when it is desired to discharge the contents of the bottle, but so constructed as to render it impossible to refill the bottle. Patent 1739393. Robert H. Harmon.

Shower-Curtain Ring—Constructed with rollers shaped to conform to the supporting rod so that when the curtain is moved to an operative or inoperative position the ring will slide freely along the support and will not become jammed. Patent 1739382. Louis Auster and Marie Auster.

Pedestal Support—Having a fixed standard supporting base, and a rotatable or turn-table top surface, which is particularly adapted for use in supporting an electric fan, or may be used generally. Patent 1739466. Henry C. Kihneman.

Built-in Bed Lamp—Having incorporated in the head-board framework a unitary construction of a lamp, the lamp being so embodied in the decorative portion of the framework that it appears a part of the bed frame Patent 1739337. James B. and James F. Von Canon.

Device for Mixing and Straining Liquids—The device having a wall slotted in such manner as to cause the liquids poured therethrough to be subdivided into converging intersecting streams thereby insuring a uniform mixture when poured into separate receptacles. Patent 1740223. Benjamin Burvenick.

Fire Life-Saving Device Embodying an endless cable having means for lowering persons from a building by means of a friction block, and means permitting ready insertion of the cable in a tortuous channel formed within the block. Patent 1740317. Carl Romson.

Carrying Device—A simple construction with which a person may lift a heated vessel, pot or pan with its contents from a stove or oven, carry it to any desired point, and there release it, without being burned. Patent 1740211. Sarkis Vahouny.

Sample Card—Including a plurality of cards each differing in shade and having an exposure area through which the skin may be compared with the card so that a face powder of the desired tint may be selected. Patent 1741080. Bernard F. Stenz.

Container and Server for Spreads—Which includes a hollow receiving body protected against dust, for holding spreads such as butter, jelly or analogous edibles, and for facilitating the uniform spreading over the surface of a slice of bread or its equivalent. Patent 1741089. Jacob Zitzerman.

Means for Safeguarding Concrete Structures Against Leaking Fractures—By forming on the upper surface grooves to form false joints, and filling said grooves with a non-hardening waterproof filler, and laminations of flexible material superimposed to allow for expansion and contraction and prevent leakage. Patent 1740110. Eugene R. Oden.

Life Preserver—Wherein a single piece of material is folded upon itself to form pockets, the bottoms being entirely seamless there are no stitches to rot, and therefore no danger of losing the buoyant material after long periods of disuse. Patent 1742104. Ernest W. Skoldberg.

Method for Varnishing Leather and Like Material—To impart a glazed and brilliant surface but without changing the appearance of the leather, by gelatinizing the surface with a suitable acid, and then applying a varnish having cellulose ester as a base. Patent 1742146. Jean Paisseau.

Inked Ribbon and Method of Making the Same—For typewriters, which includes an endless strip of tubular fabric, inserting a strip of cardboard between the runs of the fabric, passing the same between inking rollers, then reversing and repeating the operation to thoroughly impregnate the ribbon. Patent 1742093. Bertrand Paradise.

Visible-Card Index File—Comprising a transparent pocket secured to the card body for receiving a record slip, and means whereby the operator may easily insert a card in front or to the rear of the record slip. Patent 1742087. Luigi Lombardini.

Window Box—Which may be used as cold weather ice box, may be readily mounted on window sills of different shapes and sizes, and will be closed or opened with the raising or lowering of the lower window sash. Patent 1742051. James C. Young.

Juice Extractor—For extracting juice from citrus fruits, whereby a maximum amount of juice will be obtained from fruit halves, a funnel directing the extracted juice into a container. The device may be readily disassembled for cleaning. Patent 1742089. Charles Meyer.

Hardware and Tools

Cylinder-Bore Polishing and Finishing Attachment—A machine tool attachment, for finishing and polishing any cylinder bores after they have been bored with the rack tool, the device produces an absolutely smooth finish, and may be adjusted to cylinders of different sizes. Patent 1738443. Robert L. Meaux.

Metal-Bending Tool—Particularly adapted for the straightening of bent or otherwise distorted automobile fenders and running board brackets, to restore them to their original form without the necessity of removing them from the vehicle and without scratching. Patent 1737084. John R. Hilstad.

Grapple for Handling Hot Castings—Of the crossed lever type, commonly used to lift and transport heavy castings, so constructed that the hands of the operators do not come in close contact with the block, thus eliminating bad burns. Patent 1740383. Isaac L. Wessel.

Lid-Supporting Means for Cabinets or Boxes—A stay which allows of the lid being raised to a certain position and supported, but if an additional upward movement is given the stay becomes automatically released and allows the lid to close. Patent 1741081. Joseph A. Stone.

Latch for Pivoted Handles—A latch for hand implements, such as pruning shears, for holding the handles against relative movement when not in use, but which may be readily released to free the handles for operative movement upon gripping the same. Patent 1741109. William G. Heimer-Dinger.

Machines and Mechanical Devices

FILLING MECHANISM—For measuring liquids such as syrups, whereby the desired quantities may be disposed in each bottle, irrespective of the temperature or density of the liquid, measurement may be varied to the slightest fraction of an ounce. Patent 1738432. James Kantor.

ANIMAL TRAP—Having separate means for holding each jaw in an open set condition, and a trigger for each jaw affording means for independently releasing the same, whereby the trap may be sprung from either side. Patent 1738448. James A. Rollins.

MIXING APPARATUS—Which reduces mixing time to a minimum, thereby reducing power consumed, permits of dustless operation, is provided with novel means for charging and discharging, and may be operated with the least possible attention. Patent 1738440. Angus D. Mac Lellan.

BOAT-PROPELLING MEANS—A form of disc-like propeller for boats, hydroplanes, or other water craft, in shallow water or water containing weeds or other growths, which tend to foul the usual type of propellers, or over sandbars and shoals. Patent 1738410. Max W. Weir.

FEED MECHANISM—For singly feeding slugs to a means for forming collapsible tubes, in such manner that the same will be disposed in a predetermined position, the mechanism may be readily adjusted to compensate for varying thickness of slugs. Patent 1741033. George H. Neidlinger.

AWNING-ACTUATING MECHANISM—Whereby the awning may be rolled or unrolled, according to whether the roller is rotated in one direction or the other, the device is characterized by its adjustability in order to render the actuating shaft readily accessible. Patent 1740190. Earl Martin.

HIGHWAY TEMPLATE CONSTRUCTION AND MAINTENANCE MACHINE—Having surface treating blades which will construct, shape, dress and maintain the shoulders, ditches and slopes adjacent the surface courses of road beds, accurately shaped in cross section after the road has been completed. Patent 1741127. Charles E. Hair.

CLAY-TREATING ATTACHMENT FOR PUG MILLS—An attachment for mixing certain dry chemicals with liquid, and discharging the mixture into the clay of a pug mill, for neutralizing certain alkalies contained thereby so that the burned product will produce no objectionable appearance. Patent 1740504. John Grotencort.

PRESSURE-FLUID HAMMER—Reciprocated by the action of steam, yet having a wide range of adjustment so that the hammer can be manipulated at will, especially adapted for use in dressing or repairing drill bits and the like. Patent 1740818. Virgil S. Killings Worth.

RECORD-CHANGING MECHANISM FOR DISK-RECORD SOUND-REPRODUCING MACHINES—Comprising a rotative record carrying table, means for holding a plurality of records adjacent said table, and transfer mechanism which will permit the operator to select and place any disk record upon the turn table of a phonograph. Patent 1741040. Frank H. Seal and Harry Hawkins.

KNITTING MACHINE—Which permits a fine adjustment of the stop blocks on the yarn carrier bar, so that the needles may knit together smoothly in a continuous fabric, strips of different colors, without any overlap or projections. Patent 1742036. Asher Kipnis.

AUTOMATIC DRIVE FOR OPENING AND CLOSING MOLD BOXES AND METAL-CONTROLLING ORGANS IN MACHINES FOR CASTING STEREOPLATES—Operated by continuously rotating spur-wheel segments and mechanical elements, which in the working periods are moved quickly, and in the time of cooling the cast plate are moved slowly. Patent 1739432. Carl Winkler.

DISTRIBUTING DEVICE FOR LIQUIDS—Having a sucking pump for raising the liquid into measuring reservoirs, the rod of the piston of the pump controlling valves which regulate the admission and control the distribution of the liquid. Patent 1739437. Henri Boutillon.

PISTON—For use in connection with the cylinders of reciprocating motors, pumps and the like, adapted for permitting ready access to the piston pin for rebushing without requiring the removal of the pin and its rod from the cylinder. Patent 1737915. Alexander C. Carrillo.

REAMING MACHINE—Which will afford facilities for utilizing the power of a prime mover to turn the reaming tool, adapted to permit the reaming of various articles more quickly, and with less manual exertion than is usual. Patent 1739424. Harold T. Snell.

MACHINE FOR MAKING TILE—Characterized by the application, with molding pressure, of a suitable wet backing of cement to a facing layer of colored cement previously applied to a highly polished metal plate, the plate automatically effecting a trowelling of the tile surface. Patent 1739379. George B. Stead.

VALVE FOR TANK CARS AND THE LIKE—A valve which will positively prevent the escape of liquid, may be opened to any desired position, and locked in that position, and also locked in closed position, or to prevent accidental opening or tampering. Patent 1740319. George Stancu, Jr.

Medical and Surgical Devices

DENTURE—Comprising an artificial tooth, and a bridge element consisting of a flat plate of platinized gold, an integral pin on the plate and wings, which fit into a bore and recesses to receive the tooth. Patent 1738460. Jacob J. Stark.

APPARATUS FOR LIFTING AND MOVING INVALIDS—Comprising a person-supporting frame to be normally placed upon a bed or operating table, and means whereby the frame may be suspended from a carrier, raised or lowered and moved from place to place. Patent 1738758. Catherine M. Cottman.

Musical Devices

MUSICAL INSTRUMENT—Comprising a sound box for receiving an harmonica and adding to the harmony and augmenting the music produced thereby, the ordinary harmonica producing music in one key only, a knowledge of music is unnecessary in the operation. Patent 1739914. Fred C. Peslin.

Prime Movers and Their Accessories

FUEL CONTROL—An auxiliary air supply to be drawn on by the suction of the engine, at low speed the auxiliary air will be practically zero increasing slowly with the speed of the vehicle. Patent 1737196. Olaf Mortenson and Olfan De Guire.

PISTON RING—Including accurate ring forming sections and means for imparting an outward movement with respect to the piston for preventing leakage of fluid, resulting in loss of power, or entrance of oil to the combustion chamber. Patent 1739361. Henry Jaedike.

ENGINE MUFFLER—Including a series of compartments through which sound waves and exhaust gases must pass to reach the outer air, these compartments communicating only through restricted orifices which cause the sound to be completely broken up. Patent 1741078. Winthrop T. Scarritt.

Railways and their Accessories

RAILWAY-CAR-TRUCK SIDE FRAME—Which dispenses with the use of numerous heavy bolts and pins, which does not sacrifice supporting strength, and which greatly facilitates the removal of the car wheels and axles with their boxes, by an ordinary journal jack equipment. Patent 1740338. Repard H. Davenport and James Porter.

CONNECTOR FOR RAILS—A bed rail connector characterized by its structural simplicity and ready application to bed rails and posts, in a manner to fixedly secure them against movement, yet permit an easy detaching when dismounting the bed. Patent 1735307. Adolf Weston.

Pertaining to Recreation

TOY—Including a parachute and a spring gun, the parachute offering little resistance when shot and will rise to a considerable distance, but on gravitational discent it will automatically open and float lightly to earth. Patent 1738347. Hallie H. Bell.

FIGURE TOY—In which a plurality of figures, representing ducks, or any object desired, are so mounted for movement that as one advances into upright position, the other disappears producing the effect of diving. Patent 1741103. Edward E. France.

Pertaining to Vehicles

ATTACHMENT FOR VEHICLE WHEELS—Which may be readily and positively secured to vehicle wheels and tires of various sizes for preventing skidding on slippery streets, or whereby a vehicle may be removed from mud holes, ruts or the like. Patent 1738453. John C. Sheller.

AIR DEFLECTOR—For use in connection with window openings of automobile doors, being adjustable for deflecting air, rain, snow and the like away from the opening, as well as to deflect air into the window. Patent 1738418. Joseph T. Bond.

GLARE SHIELD—Adapted to be attached to, and extend forward of, the steering column of an automobile in such position that it is readily accessible for adjustment, to protect the operator's eyes from the glare of oncoming headlights. Patent 1737934. Oscar L. McKinley.

GEAR-SHIFTER MECHANISM—An electrically operated mechanism adapted for application to, and use with, any form of sliding gear transmission, for controlling the starting, low, intermediate and reverse speed and directional movement of motor vehicles and the like. Patent 1738462. William G. Stevens, Jr.

VEHICLE—In the form of an ambulance for mines, resiliently mounted so as to eliminate shocks to the injured, and whereby patients may be comfortably carried from the point of accident to the exterior of the mine. Patent 1737493. Gilbert O. Crank.

PARKING DEVICE FOR AUTOMOBILES—Which will enable a car to be parked in a space slightly longer than itself, by means of auxiliary wheels disposed at the rear axle, to be dropped into operative position for moving the car transversely. Patent 1736498. Peter Jensen.

TRANSMISSION GEAR—For motor vehicles, whereby the driven shaft is caused to rotate at the same speed as the power shaft prior to engagement of a sliding gear with its mating gear thereby reducing clashing and resultant objections. Patent 1737451. Baylies V. Clark.

CHANGEABLE-SPEED TRANSMISSION-GEAR ATTACHMENT FOR CYCLES—A complete self contained transmission entirely enclosed and fully lubricated, all wearing parts running in a bath of lubricant, adapted for use with conventional bicycle frames and may be installed by the user. Patent 1736680. William A. Toliver.

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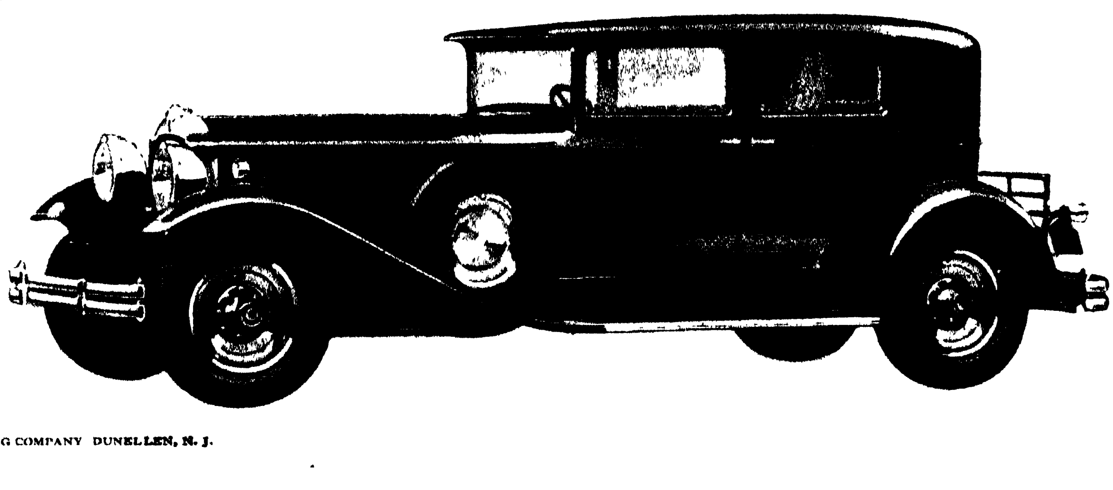

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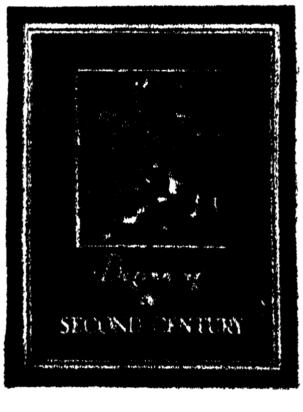

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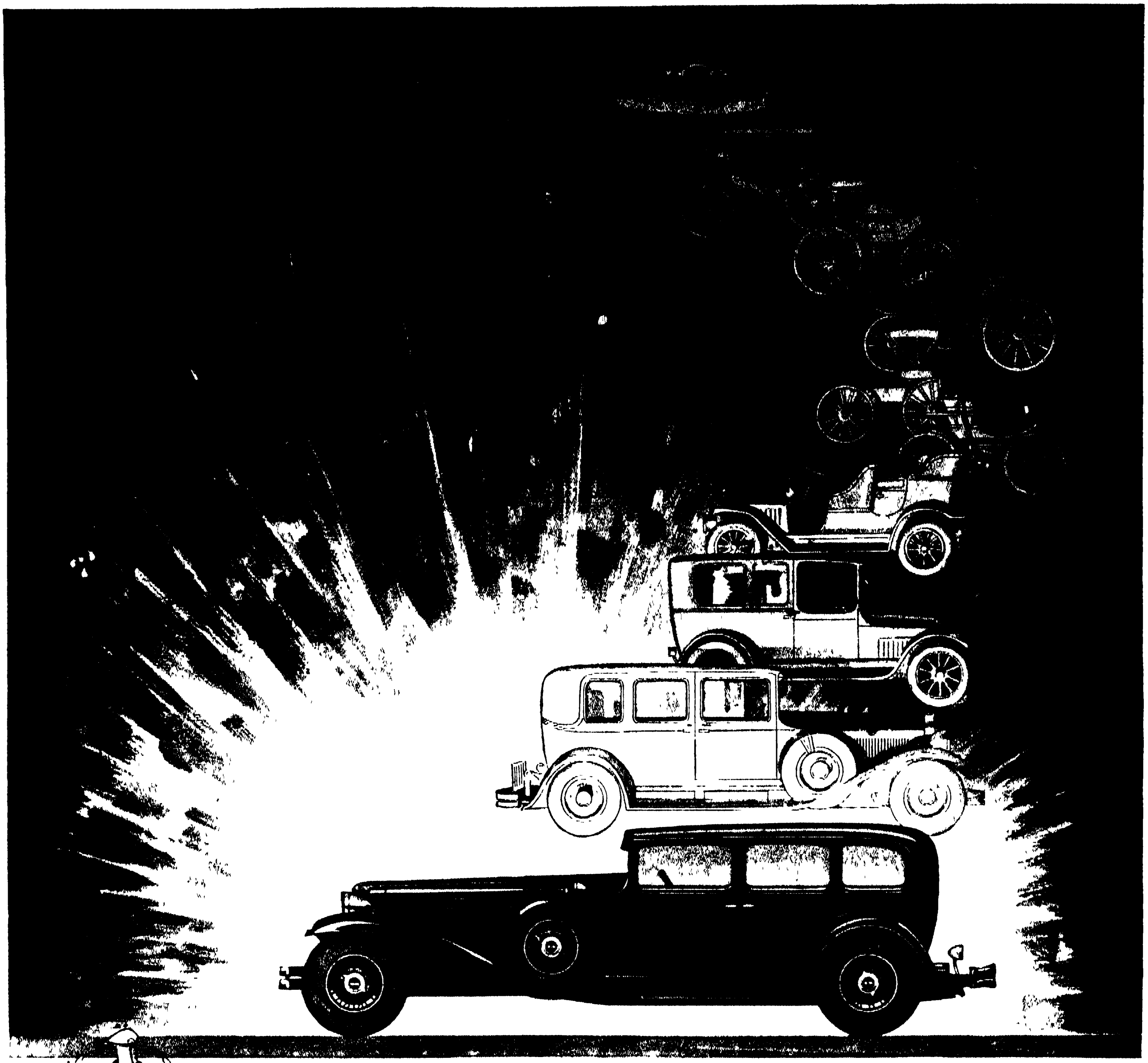

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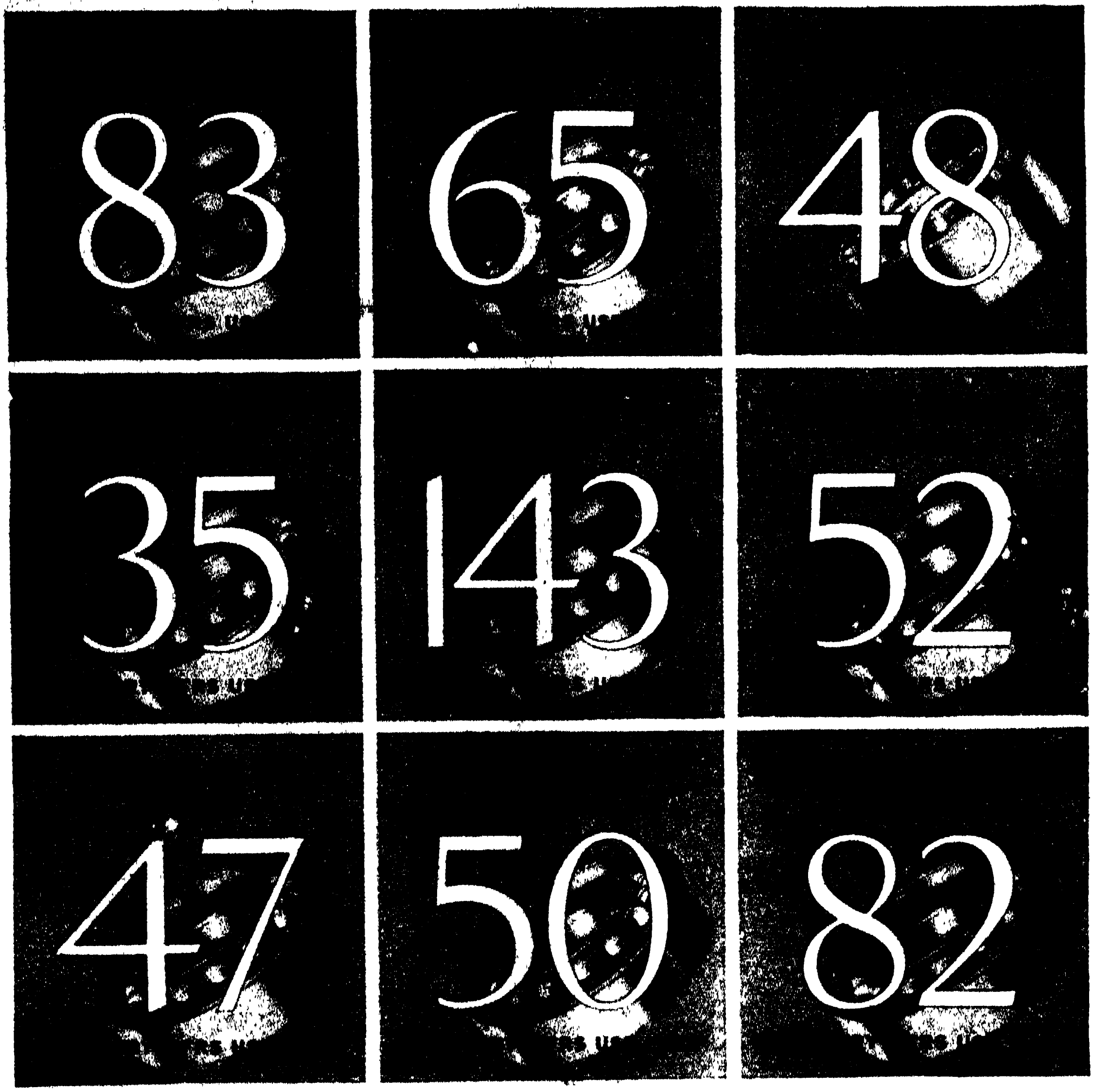

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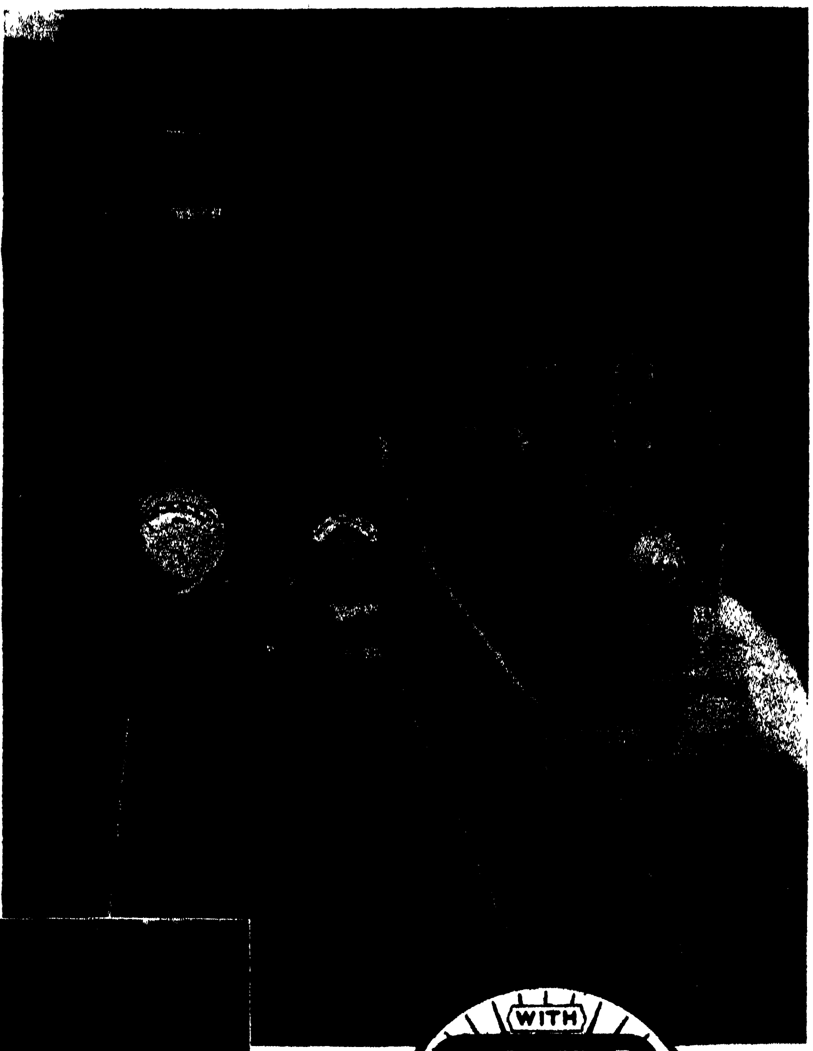
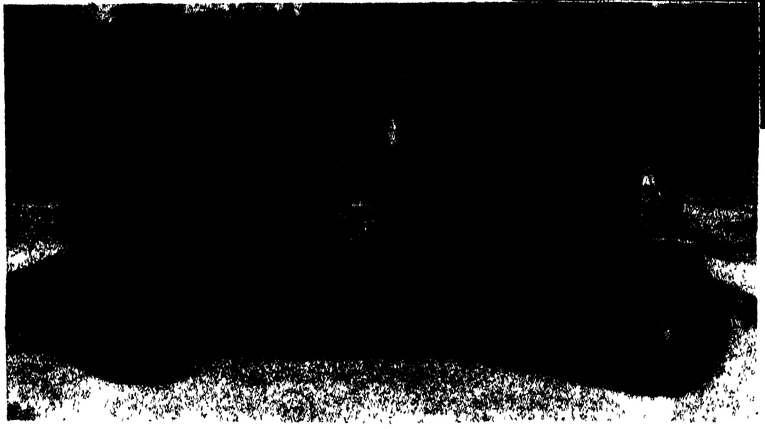
That's why thousands of service station men advise you to use Ethyl in your own car. They know that *any* car performs better with Ethyl Gasoline in its tank.

Ethyl Gasoline Corporation, New York City





Fitted into the rear of this car is the "knock" demonstration machine. (Above at right) The machine ready for action.

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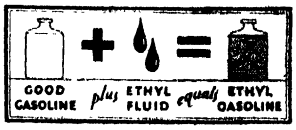

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SCIENTIFIC AMERICAN

April 1930 *ORSON D. MUNN, Editor* *Eighty-sixth Year*

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COVER

One can almost hear the throb of the locomotives shown on our cover this month, so realistically has our artist, Howard V. Brown, painted them. The groan of the air compressor and the hiss of escaping steam seems to imbue them with life, and they appear as huge panting monsters anxious to be on their way. "Awaiting the Dispatcher's Orders" therefore serves as a fitting introduction to the article "'Round a Round House" on page 291.

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Los Angeles, San Francisco, Seattle, and Atlanta

Looking Ahead *With the* Editor

May—Aviation Number

THERE has been some pessimistic talk relative to the continuation for a long period of the recent slump in aviation. We take little stock in such talk; we have faith in the industry. It may be marking time now but soon, we believe, it will resume its march with a greater stride than ever. The younger generation will attend air schools in greater numbers, more individuals will purchase planes for private use, and certain present-day concepts of air practice will have to be revised. In our May issue, therefore, we will publish an article on air schools which will tell both parents and youngsters how to select schools for the youngsters' training; a discussion of what details of construction, what features of operation, and what factors of safety to look for in the plane you buy; and a third article which shows that stunting is desirable—sometimes. Still another will describe a large air transport system; and shorter items will cover various interesting and technical advances that have been made by the industry.

Tweedle-dum and Tweedle-dee

THE difference between these two, from "Alice in Wonderland," is popularly considered so trivial as to be unworthy of notice, but the difference between Tweedle-dum and Tweedle-dee, in scientific research, "has been responsible," you will be told in a coming article, "for the very large number of advances that have taken place in science during the past four or five centuries." Look for this absorbing story of science.

Professor Michelson

WE have on hand ready for release a splendid appreciation of Professor Michelson and his work. It shows the human side of this man who is often thought of as a thinking machine; and carries us through his life from his entry into this country to the present day. His graduation from the Naval Academy, the Michelson-Morley experiments, his invention of the interferometer named for him, and his determination of the velocity of light are interestingly discussed.

Dirty Air

LOOKING toward the further suppression of smoke and dust producers, the Mellon Institute of Pittsburgh has been conducting researches on air pollution which should have far-reaching effects. The article on this vital subject, which we shall publish soon, makes not only an interesting story but should prove suggestive of a method of tackling local air pollution problems in many cities in this country and elsewhere.

Every Issue Fully Illustrated

¶ *Men are known by the magazines they read. What easier road to distinction could there be than reading the* SCIENTIFIC AMERICAN—*at four dollars a year?*

Among Our Contributors

Theo. Krysto

DURING his long life Dr. Krysto has been a physician, a farmer, a writer for Russian magazines, an adviser to the Governor General of Western Siberia, a Russian government Agricultural Commissioner to the United States, a Senior Specialist in the Russian Department of Agriculture, a director in a large company, and again a physician in the little California town of Alhambra. Now, at the age of 72, he is starting an enterprise which may be of inestimable value to mankind. His aim is to show the world that two of its scourges—malaria and blood-sucking mosquitoes—can be eradicated easily, cheaply, and quickly by natural methods.

Robert E. Goode

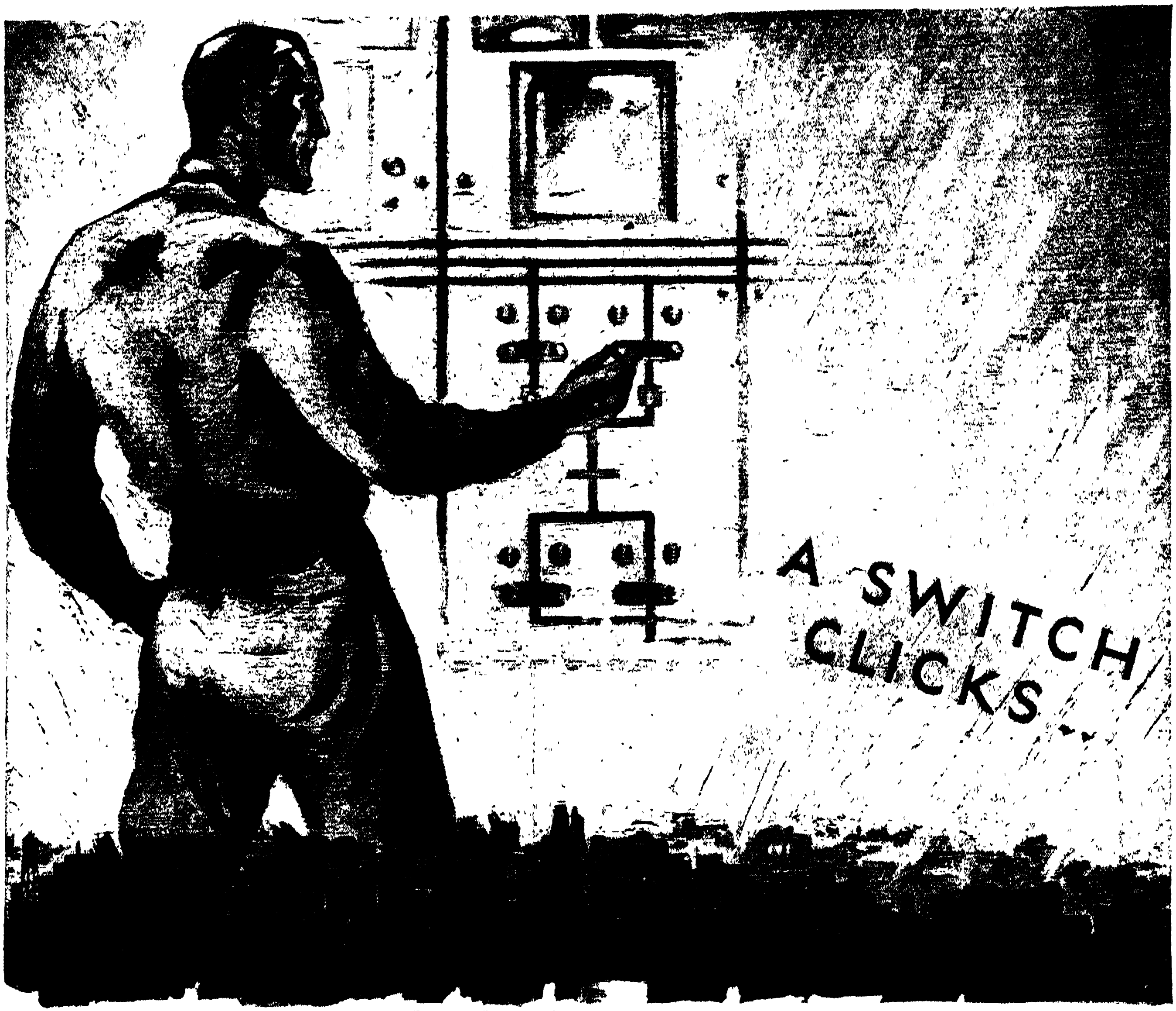
MR. GOODE belongs to that small army of civilian technicians which is doing good work for the navy. He is a photographer and an artist attached to the Naval Air Station at San Diego, California. He has taken excellent snapshots from the air with all kinds of cameras, including the familiar cheap box type. His article in this issue thus is based upon extensive experience—no better authority could be desired.

Roy L. Moodie

HAVING taken degrees in paleontology and in anatomy, Professor Moodie is able to gain a perspective of past and present; his studies have linked the pathological past of *homo sapiens* with the present. His researches have been in paleopathology, the history of anatomy, the development of the skeleton, and cognate subjects. Professor Moodie has taught biology, zoology, and anatomy, and has taken part in paleontological expeditions to our great southwest.

James A. Tobey

DR. TOBEY is a graduate of the Massachusetts Institute of Technology, where he received the first doctorate in public health (Dr. P. H.) given to a non-medical graduate. He was formerly Associate Editor of the *American Journal of Public Health* and has written extensively on the subjects of hygiene and sanitary science. Dr. Tobey is now Director of Health Service for a large company which operates in New York City.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and 1,253,000 Horsepower is Released to Industry

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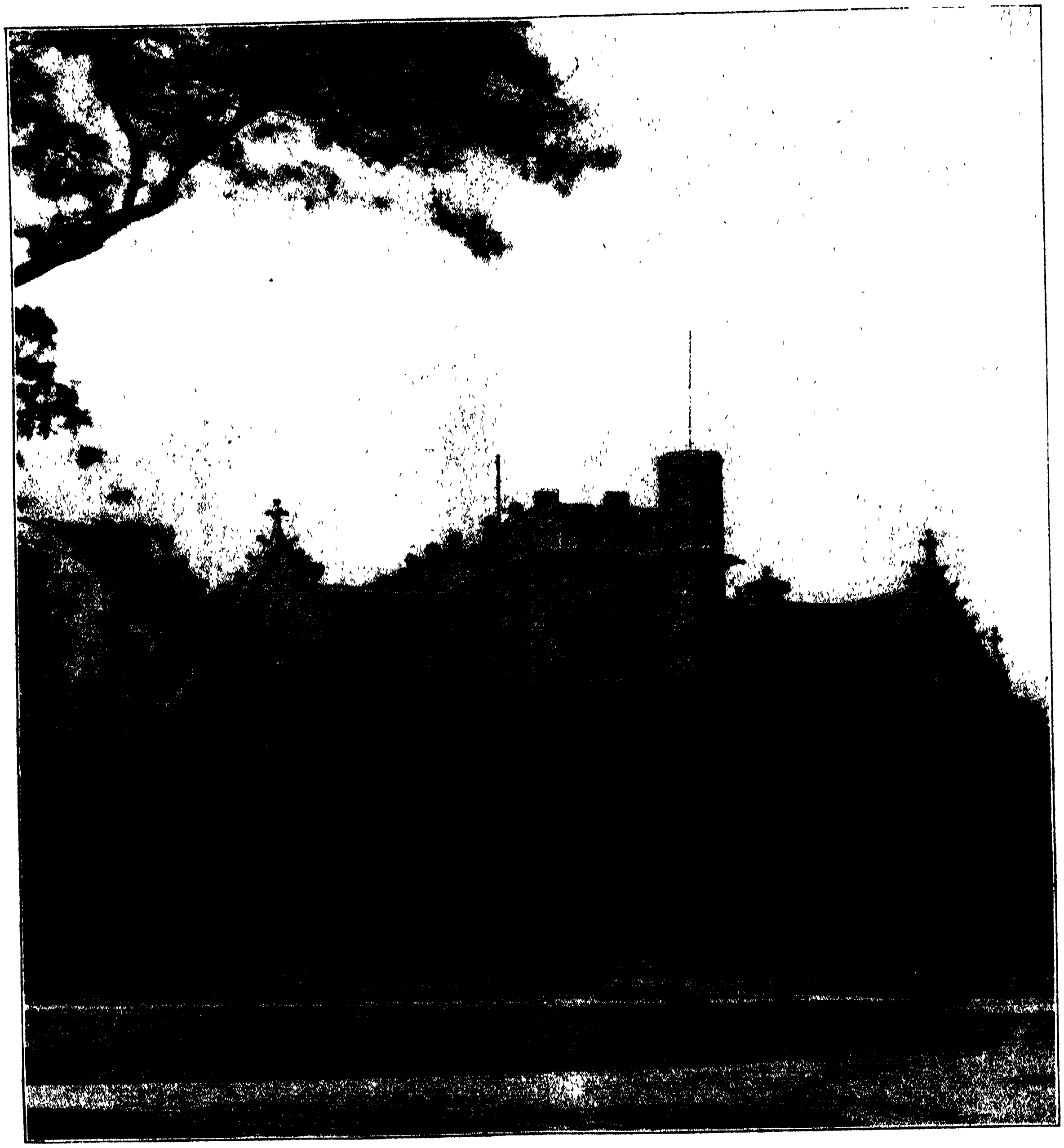
Information regarding the opportunity in Los Angeles County for any specific industry will be sent upon request to Industrial Department, Los Angeles Chamber of Commerce.

SOUTHERN CALIFORNIA EDISON COMPANY . . . LOS ANGELES

Arthur Jeffrey Dempster

THE Thousand Dollar Prize of the American Association for the Advancement of Science has been awarded this year to Professor A. J. Dempster of the famous Ryerson Physical Laboratory at the University of Chicago, for his "noteworthy contribution to science" in proving that the proton has wave characteristics. In the words of Professor Arthur H. Compton, Nobel Physics Prize Winner, also of Ryerson Laboratory, "the most important contribution of 20th Century physics is that the physical world can be reduced to three kinds of particles—protons, electrons, and photons, [see Professor Compton's article, SCIENTIFIC AMERICAN, February, 1929.—Editor], and that each of these particles has also the characteristics of waves. The last stage is the proof that the protons, the positively charged parts of matter, have wave characteristics. It is this completion of the great work of 20th Century physics which has been accomplished by Professor Dempster." In that Dr. Dempster's discovery demonstrates the dual nature—particle and wave—of the proton, it is one vindication of the prediction of the French physicist de Broglie, mentioned on this page last month. Following de Broglie's prediction Davisson and Germer of the Bell Telephone Laboratories proved the wave nature of the electron; Dempster's research does the same thing for the proton.



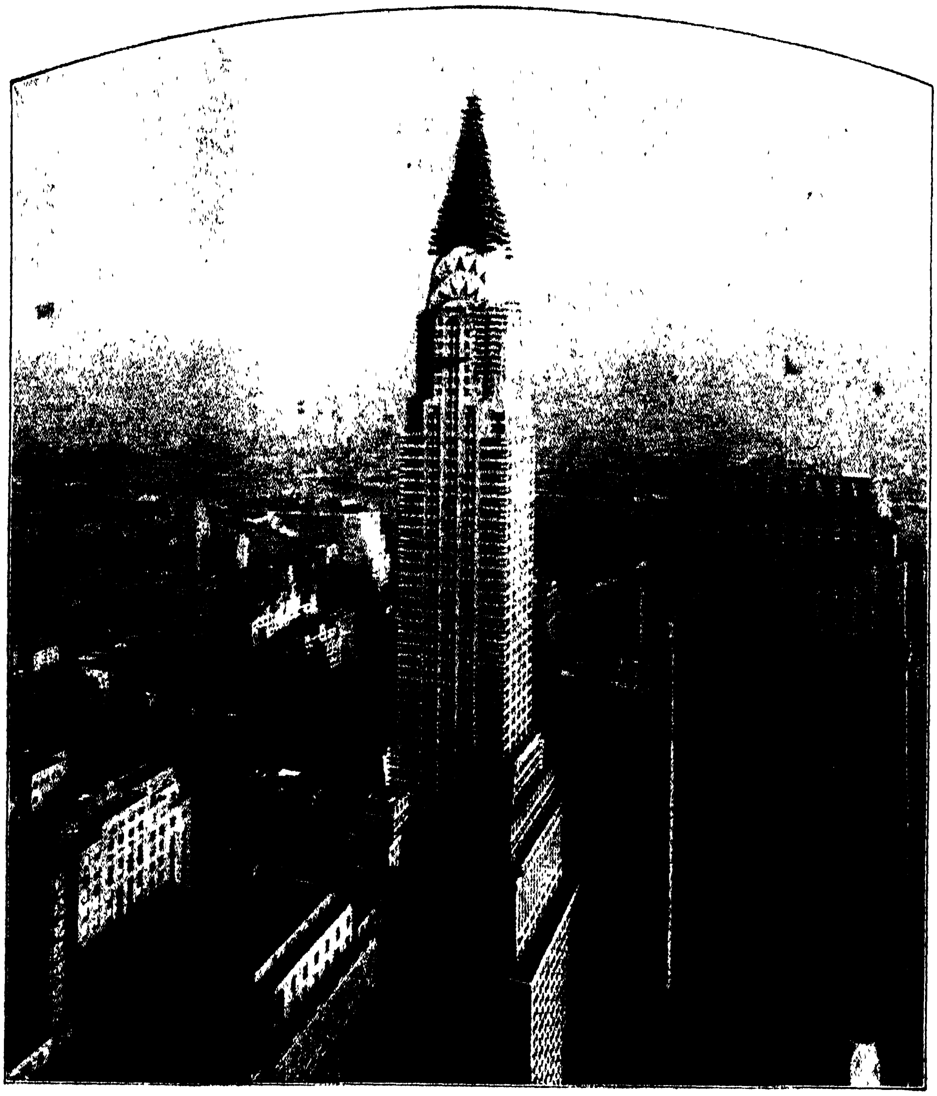
America's Foremost Physical Laboratory

THERE is no formula for determining which is the "foremost" physical laboratory, but the Ryerson Laboratory at the University of Chicago has given the world so many famous physicists that the majority of those who are qualified to judge would perhaps so nominate it.

How is such a choice as this arrived at? What makes a scientific institution a leader? That which is most likely to assure advance is the strong inspiration and leadership of an outstanding personality, and it is therefore not a far cry to attribute Ryerson's supremacy mainly to the leadership of the great physicist Michelson who has been its head from 1892 until recently.

Michelson, Millikan, Compton—what a trio this center of physical research can boast! Professor H. G. Gale whose name is linked with Michelson's in connection with ether drift experiments; Samuel G. Stratton, President of the Massachusetts Institute of Technology; Professor A. J. Dempster, whose picture is on the previous page; Dr. W. F. G. Swann, Director of the Bartol Research Foundation; Dr. Frank B. Jewett, President of the Bell Telephone Laboratories; and Dr. C. J. Davisson of the same great laboratories, who proved the wave-atom theory—these and some 130 other physicists are all "descendents" of the Ryerson tradition.

In an address before New York business men, the physicist R. A. Millikan, now of California Institute of Technology, spoke on "Michelson's Economic Value." He proved that Michelson was a bigger world asset than any billion-dollar corporation, or all of them in existence. Thus much can one simple man accomplish for the world by the right kind of leadership in science.



ON AN OLD GOAT FARM

According to an old drawing, a copy of which we saw a few days ago, the site occupied by this already famous structure, the Chrysler Building, was a goat farm only 55 years ago. The section beyond it, one may well imagine, must have been open farm land with a residence here and there. In the distance is the East River and one of the bridges spanning it. In this view, taken a short time ago, the tower is not quite complete

Manhattan's Mightiest "Minaret"

Many Unique Features and Engineering Problems Involved in Building the World's Tallest Structure

By F. D. McHUGH

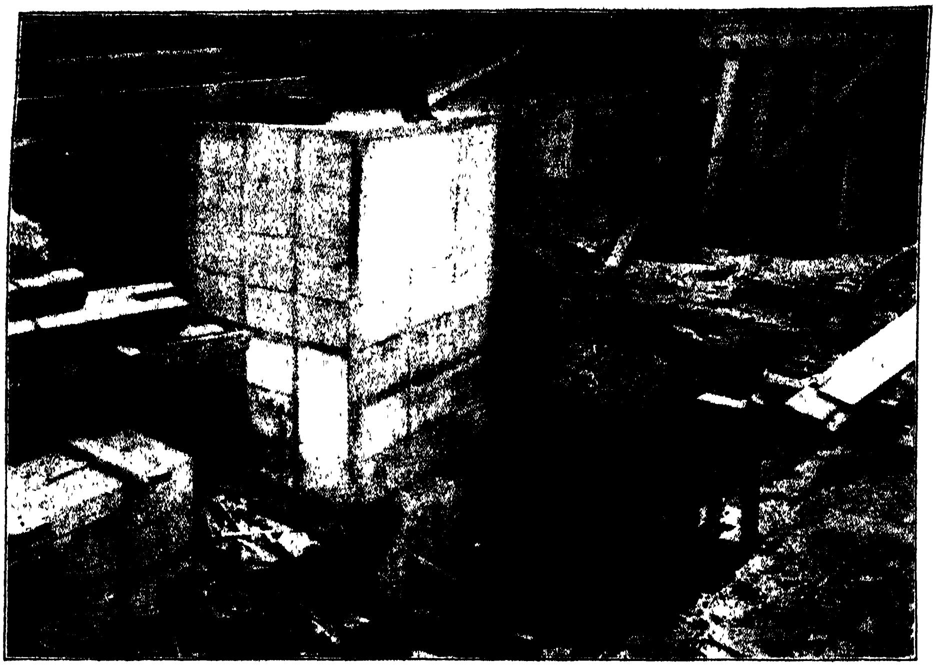
STANDING out like some shiny new minaret among many squat mosques of business, a needle-pointed tower building has been added to the mid-town skyline of New York City. And if one is fortunate enough to view it from the exact angle at which the sun is reflected directly, then he will be treated to a sight that will impress him with its unique quality: he will see what appears to be a towering sword of fire topping the structure. Perhaps he will be puzzled, and upon inquiring will learn that the finial spire of this newest of New York's new edifices, the Chrysler Building, is entirely covered with stainless steel and, furthermore, that this metal is used generously on cornices, arches, and other parts of the upper tower structure.

The Chrysler Building is the tallest building, and, in fact, the tallest man-made structure in the world. It tops the Woolworth Building, holder of the first record for many years, by more than 200 feet and beats the 1000-foot Eiffel Tower of Paris, holder of the second record since 1889, by 44 feet. It rises 1044 feet above the street curb line.

FROM a base approximately 200 feet square occupying the plot on the east side of Lexington Avenue between 42nd and 43rd Streets, this structure rises through several setbacks to the 31st story at which point the tower starts. The tower at this level, and continuing to the 59th story where there is another set-back, measures about 88 feet by 107 feet. The 59th story set-back changes the plan of the tower so that it measures 88 feet by 88 feet. Then from the 61st floor setbacks, the contour starts changing into the multi-arched dome which finally converges into the needle-like finial. Below ground there is a basement, a cellar, and a sub-cellar; and above ground, running into the dome, there are 71 stories, plus the final 34 feet of the dome itself, plus the 185-foot finial. The total floor area is approximately 1,200,000 square feet. In the basement will be a restaurant, stores, and bank vault; and it will be accessible, through corridors, to both the Grand Central Station and the subway.

Besides the stainless steel, which is so strikingly effective in appearance, there are many other unique features about this building and it is the holder of other records in addition to the height record. Also several unusual problems were encountered in the work of construction.

It has been the accepted, although



TO SUPPORT A TREMENDOUS LOAD

One of the huge column foundation pillars of concrete. This supports a column which runs directly through to the top of the building, its total load being approximately 3700 tons

tragic, belief that, in erecting the steel for a modern building, one workman will be killed by accident for every floor of the structure above the fifteenth. On the Chrysler Building 2500 to 3000 men were employed at all times and a number of accidents occurred, but not one resulted in death outright and only one of those injured died later. This splendid record of safety was due to the many precautions taken by the builders and to the general systematization of the work.

GENERAL construction methods usually allow piles of structural materials of various kinds to be stored in any available place awaiting the opportunity to be carried to the point needed, after the foreman concerned with their disposal is located. This is conducive to confusion, and confusion, where hundreds of men are continually active, increases the danger. In going about their individual tasks, men stumble over this stored material or step on loose ends and fall perhaps many floors.

This condition did not obtain in the Chrysler Building. When a truckload of material—sand, cement, steel, et cetera—arrived at the street office, the man responsible for its disposal was immediately called on the telephone. No matter in what part of the building he may have been at that moment he would receive the call, for the temporary telephone line extended throughout, and all this man had to do was to listen for his particular number of rings, or code call, for bells rang on all floors. Upon getting the message, he gave instructions for placing the material at once where it would be used.

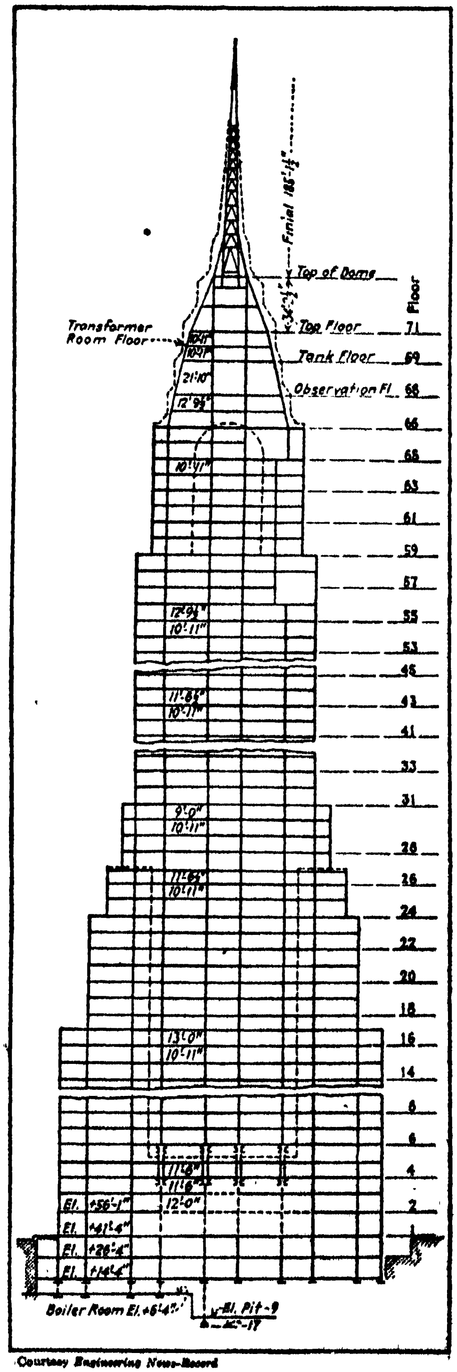
Other safety measures adopted were the use of guard rails with locked doors around the construction elevator shafts where they pass through each floor, and the use of a minimum amount of scaffolding on the outside of the building at all times. In fact, the materials-hoisting elevator shafts and their necessary scaffolding, composed primarily of steel tubing, were all grouped in the rear of the building.

Another record held by the Chrysler Building is that of possessing three of the longest continuous elevator shafts in the world. Indeed it is said by some that in this building the ultimate limit of practicable elevator operation and therefore the most economical building height has been reached. This belief is based upon the claim that it would be impracticable to attempt to support an elevator car and its cables for a direct run of more than approximately 1000 feet, and furthermore that shafts in a number of relays would take up too much revenue-producing space.

ON the other hand, the American Institute of Steel Construction reports as a result of an extensive study of the height question that while 1000 feet seems to be the maximum economic height, the maximum physical and engineering limit is 2000 feet. It is interesting to note their reasons for this figure; namely, the enormous weight of the elevator cables that would be required, and the capacity of the human ear drum to withstand the vibration in an elevator car traveling at a speed that would have to exceed 1500 feet per minute.

One of the most important factors in the design of a building of this character is the problem of wind stresses and the general stiffness in the joints of the multi-story rigid frame. Wind bracing is necessary primarily to prevent occupants from getting seasick or frightened. In the Chrysler Building special care was taken in selecting column sections in the center of the building to get continuous framing throughout and enable rigid bracing to be attached. This required a great deal of special study inasmuch as grouped in this part of the building are the elevators and stair openings which were arranged as compactly as possible in order not to use any more rentable space than absolutely necessary.

Structural steel was so designed and erected as to distribute wind stresses throughout the structure. There are



Courtesy Engineering News-Record

SCHEME OF THE BUILDING

Sectional diagram of the building showing the general layout, set-backs, pipe galleries, tower, observation floor, et cetera no "soft" spots but a harmonized balance of members so that neither a steady wind nor a sudden gust will distort the building or cause jarring vibration. It is expected that the building will vibrate, but this vibration will be rhythmic. The writer visited the building a short time ago on a fairly windy day and was not aware of any vibration in the tower stories. This was due perhaps to an unconscious physical accommodation to sway. For the purpose of further study of this question, wind stress indicators may later be installed at all telltale points in the building.

The erection of approximately 21,000 tons of structural steel offered several unusual problems, although the general framing does not differ radically from that of other skyscraper buildings.

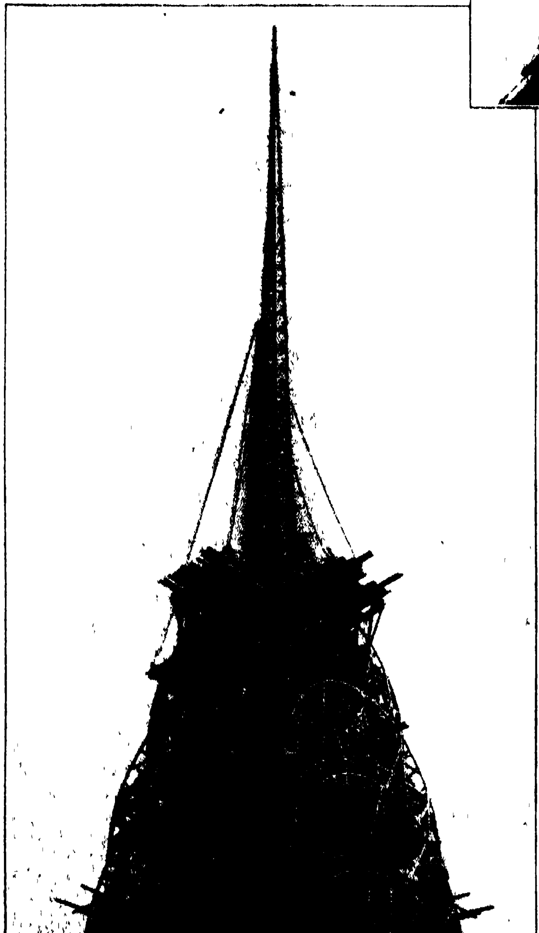
The great elevator hall extending through the building made it necessary to carry four columns on two-story trusses. These trusses extend through the fourth and fifth stories, the columns extend to the 58th floor, and each carries the tremendous weight of 3,800,000 pounds. The section of one of the columns supporting the truss has an area of 532½ square inches, and its total weight per lineal foot is 1770 pounds!

THE four center columns are in an unbroken line to a point 30 feet above the 74th floor, from which level the spire starts. In the dome-like part of the tower the 12 wall columns are sloped, following as closely as possible the exterior walls. Structural steel angles, bent to follow the architectural outline of the dome part of the building were of such unusual construction that they were fabricated by a ship-building company.

It is interesting to note that the total load of the building, including all live and dead loads, is equal to the combined tonnage of three large battleships—that is, 112,000 tons!

In the erection of the finial, the Chrysler Building scored a triumph which for daring conception and unique execution has not been equalled for many years, if at all, for the interest it aroused among engineers and laymen alike. The architect, William Van Alen, originally designed the structure to be 808 feet high, surmounted by a dome composed of a series of gradually decreasing arches, and, finally, by a cupola-like dome.

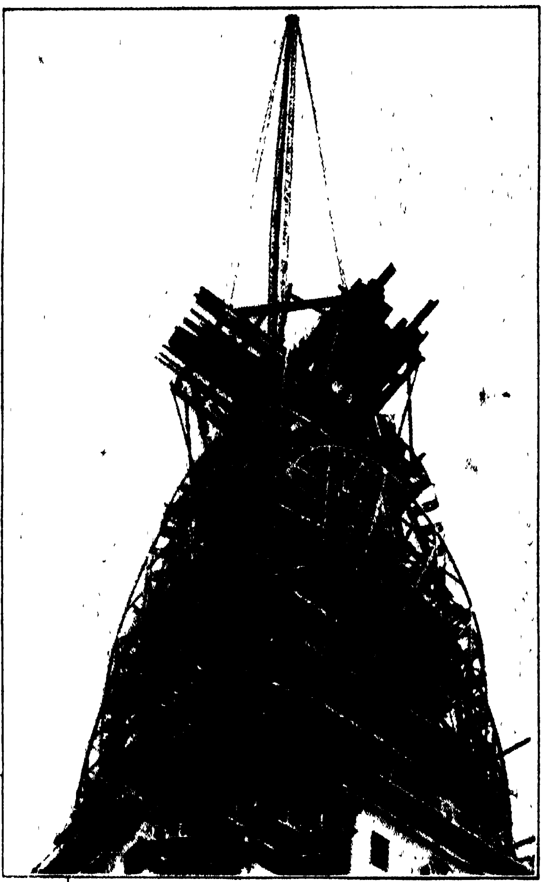
Construction work started in October, 1928, and by the fall of 1929 the steel structure was rapidly nearing completion. In the meantime, the design of the upper part had been changed, the finial being designed to take the place of the cupola-like dome, but this fact had been kept secret. Then suddenly on a day in November, 1929, passersby were amazed to see the finial, a lattice-like structure, emerge full grown from the top of the steel and push skyward a distance of 185 feet.



THE LATTICE-WORK FINIAL

This unique spire was assembled within the building and erected in place by lifting it out vertically. Note intricate framing for the tower

Since it was expedient to erect this finial as a unit and its weight of 27 tons precluded the possibility of lifting it all the way from the street, and since, furthermore, it would have been difficult to up-end into position, it was assembled vertically within the building frame. Fortunately, a fire tower existed in the top section of the main structure and so the finial was built therein of formed and numbered sections. Since its base measured only 8 feet on a side, this operation was simply done by providing a support at the 65th floor level and temporarily omitting some minor sections of the building frame.



FOR RAISING THE FINIAL

The platform and the 20-ton derrick that was used, its boom being held practically vertical

An outrigger platform was erected all around the top of the dome and a guy derrick was mounted on this. A line from the derrick was then attached to the completed finial and it was pulled out vertically, inched slowly upward until finally its base was in position for bolting and riveting into place permanently. In passing, it may be said that this unique operation may never be necessary or desirable in any future building.

SEVERAL floors of the completed structure will be devoted to operating equipment. The cellar and sub-cellar will be used for the installation of mechanical equipment, mechanics' shops, main switchboard room, transformer vault, telephone room, and store rooms. The 30th and 60th floors will be pipe galleries, the entire space of both being taken up by steam mains and distributing lines, electrical apparatus, and general operating equipment. The 68th floor will be used for observation purposes, the 69th for water tanks, and the 70th as a transformer room.

One of the striking features of the building is the manner in which electricity at a voltage of 13,200 was brought directly into the building. High-tension cables carry this current to four transformer vaults located at different levels. These four transformer banks are treated as regular transformer sub-stations and the fact that they are located vertically one above the other, instead of horizontally, as along a highway, in no way changes their functioning.

AS THE WORK PROGRESSED

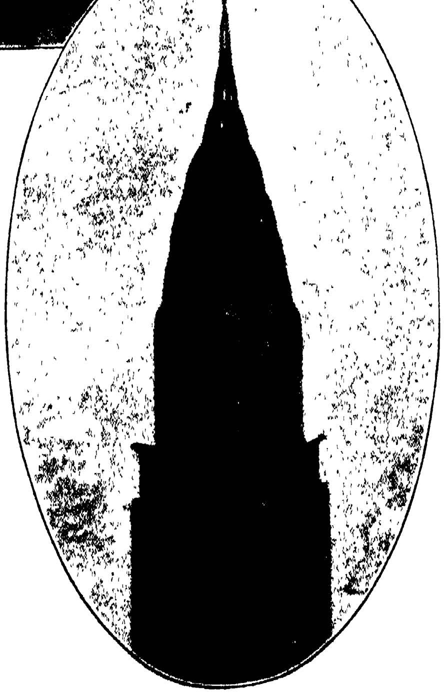
It will be noted that the structure was kept comparatively free of scaffolding

The secondaries of these transformers are brought out to switchboards where they become the points of origin of the various customers' feeders. The high-tension feeders which are brought in from the street to supply the primary energy for the transformers are kept isolated from the building in raceways embedded in concrete.

Another feature of the Chrysler Building's electrical design is the full recognition of the arrival of the electrical era expressed in the facilities provided on every floor for the application of electricity to every office need. This is done by the installation of underfloor raceways by means of the Orangeburg duct system, sections of which are spaced at sufficiently close intervals to allow an electrical connection to be made at any point within the extensive floor area of the building.

Seasonal and even hourly demands for heat may be taken care of due to the effective arrangement of the heating system. That is, during seasons in which the sun heats up offices with a southern exposure and leaves those on the northern side cold, during the morning when the offices on the western side are cold, and during the afternoon when offices on the eastern side are cold, steam may be turned into the pipes feeding the radiators of the cold tiers of offices. To make this possible, the entire heating system has been divided into four zones.

Steam for heating the building will be purchased from the New York Steam Corporation. For the benefit of those unfamiliar with this system, it should be explained that this corporation has several steam plants at locations convenient for the reception of coal shipments and sufficiently far removed from busy sections of the city to prevent their throwing over the city quantities of smoke and soot. Among the advantages of this system may be listed the facts that a cheaper grade of coal may be burned, fuel does not have to be trucked through heavy traffic, and the building purchasing steam in this manner does not have to install machinery and equipment.



THE COMPLETED TOWER

An artist's rendering of the tower with its finial, as it will look when complete

The steam mains of this corporation extend over a wide area of the city, constantly carry live steam, and may be utilized in the same manner in which electrical power lines carry current and are tapped. For the Chrysler Building, the steam mains are tapped at two points, one on the 42nd Street side and one on the Lexington Avenue side, so that steam may be supplied from one or two of the steam company's stations. The entering steam is metered and then taken through a pipe gallery to a main supply riser which carries it, at a pressure of 40 pounds per square inch, as far as the 60th floor.

In the pipe galleries at the 30th and 60th stories, the steam pressure is reduced to feed a set of secondary supply mains. From the mains on the 60th floor, steam pipes are carried up to the top floor and down to the 31st floor. From the mains on the 30th floor, steam is carried down to the 17th floor. Finally, steam is carried from the cellar pipe gallery upward to the 16th floor. Welding was adopted for joints and connections wherever practicable — in the sub-cellar level, throughout the main supply riser, and in the 30th and 60th floor mains.

TWENTY-EIGHT passenger elevators, two service elevators, two to the tower, one for the restaurant, and a sidewalk lift have been installed. The passenger elevators and the two tower elevators are Otis electric, gearless, machine type, with full automatic signal control and automatic leveling. This type is practically self-operating since the operator simply pushes buttons for all the floors desired on any one trip, and the mechanism stops the car at those floors as they are reached, levels off, and opens the doors. Likewise, a signal from any floor automatically stops the car as it reaches that floor. The passenger elevators have a capacity of 2500 pounds and a speed of 1000 feet per minute—or about 12 miles an hour, vertically!—but will be run at 700 feet per minute until the city code allows the higher speed.

Cold water for fire and sanitary purposes throughout the building is pumped to the upper floors in three stages by means of house pumps and fire pumps. By installing brass pipes in the hot water system throughout and on the cold water system for all pipes up to and including 2½ inches, the owners have exercised forethought to obviate the trouble of rusted and clogged pipes in the future.

Other problems were encountered and other unique practices or adaptations than those described here were involved in the building of this structure, but they were of such a specialized or general nature as to fall without the scope of this article. W. R. Squire & Son and H. G. Balcom designed the steel, and Post and McCord were the steel contractors. William Van Alen was the architect; Fred T. Ley & Company, the general contractors; and Louis T. M. Ralston, the consulting engineer.

OUR POINT OF VIEW

Safety Needed

THERE is quite a contrast between the remarkable record of safety achieved by the builders of the Chrysler Building, and the apalling death rate suffered during the past year by house wreckers. Only one death resulted from accidents sustained in construction work on the above mentioned building, but 20 deaths are reported as the result of house-wrecking operations in New York City in 1929, primarily because of the method of demolition.

Prior to last year, buildings and houses being destroyed to make way for larger, more modern structures, were demolished floor by floor. House-wrecking contractors then conceived the method of breaking through all floors of a building, regardless of height, and dumping all material directly to the basement for removal. This did speed up demolition, but at the same time it subjected the workmen to far greater danger than before because, with floors broken through, nothing is left of a building but a mere shell of walls on the top of which laborers must work. Practically all the men killed while working in this way, fell from these walls directly to the basement, in many cases 10 to 15 floors.

Today there is necessity for speed in all industry and construction work but this speeding up in all cases increases the hazard and the demand for more effective safety measures. Whether, in house wrecking, this points to a resumption of old methods or to the adoption of positive accident-prevention measures, we can't say; but something must be done, for time-saving is no excuse for taking human life.

Business and the Individual

THAT the responsibilities of American business to the individual, the nation, and the world, are increasing more rapidly than ever before was pointed out in an address given some time ago before the Chamber of Commerce of the United States by Julius H. Barnes.

"In this present era of applied invention," said Mr. Barnes, "of trained intelligence, of old industries expanded, checked, or displaced, of whole new industries rising with the magic wand of invention, and of high speed in the creation of wealth and possessions, we have a fluid economic structure that challenges the imagination. The social habits, indeed the individual character of our people, are under the influence of new and vast forces. The scene shifts hourly. The world of everyday has become a fairyland."

In 17 years our national income has increased from 32 billion dollars to 90 billion dollars annually. This is significant because, as Mr. Barnes said, "America has learned that national wealth is the aggregate of individual possession and attainment and that the stimulated production of the individual inevitably builds higher the aggregate of national possession." It is significant also that the relative national wealth of the United States against that of Great Britain is almost the exact relationship of the relative per capita horsepower: 4½ to 1. America possesses two thirds of the world's banking capital and heads the list in per capita ownership of prosperity-producing machinery. Contrast our machinery equipment of 24 dollars per person against, for example, that of Russia of one dollar per person.

Business, in days gone by, may have been ruthless and savagely unjust; nevertheless it is the basis of a public and individual welfare unequaled anywhere in the world. Having outlived the ethics—or lack of them—of past days, American business now has many duties to perform. It must maintain its present high standards and must appraise the background of those forces that induce economic, political, and social changes; for they influence the markets of the world, therefore the wealth of the nation and, consequently, individual welfare. In short, business has responsibilities, the ramifications of which touch every phase of human endeavor, and it must, therefore, maintain public confidence by continued research and progress, service, and unimpeachable ethical standards.

Who Says Hard Boiled?

THE world of science will give a good round cheer when it learns that a public utility company has surrendered five thousand good hard round dollars for the sole purpose of enabling some archeologists to dig up areas behind a newly constructed dam, because these areas are believed to contain Indian artifacts and are about to be flooded. Louder cheers will be added when it is learned that the money was forthcoming without a struggle; in fact, it was voluntarily contributed.

The company in question is the Pennsylvania Water and Power Company, the dam is at Safe Harbor in that state, and the official recipient of the excavation fund is Mr. Frederick A. Godcharles, Curator of the State Library and Museum.

When supposedly "hard-boiled" money-making concerns do things of this kind, and especially when their stockholders permit such diversion of funds without promise of a cent's return, we think it signifies that things are looking up. Enlightenment is spreading, even to the pocketbook.

Naval Conference Problems

AMID surroundings most appropriate for an epochal event, the London Naval Conference came to order; delegations from five great naval powers, assisted by the cordial welcome of King George and the British Government, quickly established a friendly atmosphere conducive to the solution of the various intricate problems confronting them. The leader of each delegation in turn indulged in optimistic generalities, made guarded reference to the naval needs of his state and truthful disclaimers of hostile intent. No new facts were developed or, by the initiated, were expected to be developed; the press of the world had been discussing for months the critical points confronting the delegates; and literally no new facts remained to be revealed.

It is well that these friendly formalities increased the understanding begun by the Hoover-MacDonald conferences on the Rapidan, for as soon as the delegations attempted to translate genial generalizations into concrete categories of ships, the carefully concealed but well known frictions exposed themselves to view. After our long struggle with Great Britain over the cruiser parity it will surprise most Americans to learn that Europe still suspects a secret Anglo-American understanding. Yet such is the persistent European suspicion.

After the conference opened, there was considerable maneuvering for position, similar to the preliminary moves often observed at our national presidential conventions. France seemed to have all the advantage at this stage, until Mr. Stimson stated the American position and Mr. MacDonald followed with the British reaction. Unfortunately the American and British statements appeared to confirm the European impression of an American-British understanding and irritated the French who still remember how they were isolated at the Washington Conference.

(Please turn to page 328)

Can the World Banish Malaria?

A Physician's Practical Plan to Rid the World of the Mosquito-Borne Disease; a Plan Which Nearly All Can Test

By THEO. KRYSTO, M. D.

Will You Take a Hand?

PROFESSOR DAVID STARR JORDAN, former head of Stanford University, famous naturalist, expert on mosquitoes in relation to malaria, and Corresponding Editor of this magazine, states that "Dr. Krysto's suggestions may prove of tremendous worth to the world. I think," he writes, "that you will be making no mistake in printing it." We hope to receive in Dr. Krysto's behalf communications from readers who may have noted the peculiar antipathy between the leguminous plants and the organism of malarial fever; also from any who may be led to try out this year the Krysto plan of elimination of the disease—*The Editor.*

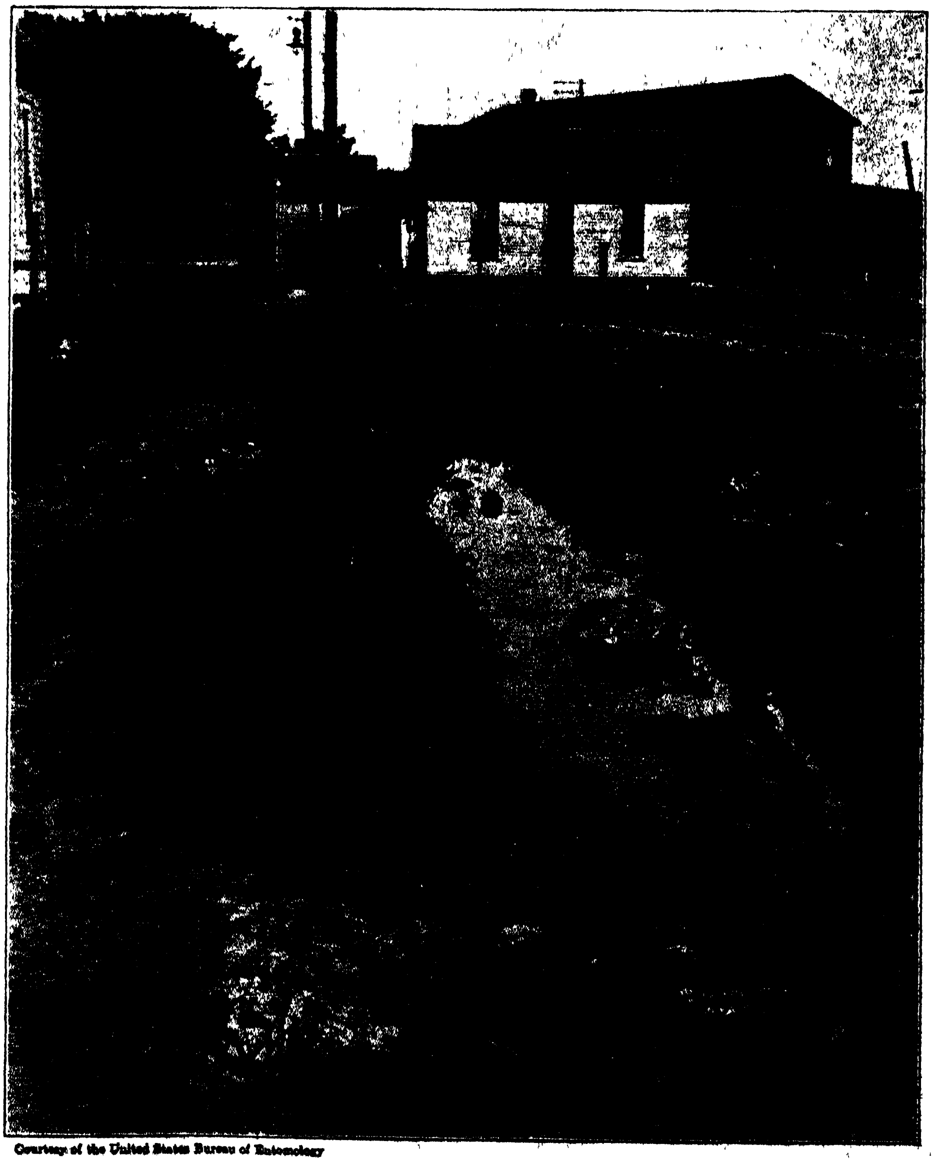
I WISH to show the people a way to free themselves of malaria and of human blood sucking mosquitoes. I also want to show that this liberation could be effected easily, cheaply, and in a short time. This is the discovery of a sober physician, made 33 years ago, verified since by hundreds of cases in Europe, Asia, and both Americas, and confirmed by recent discoveries and observations of several authorities. To this I shall add another discovery made by a solid French scientist and confirmed by his conspicuous demonstrations—not in a laboratory but in real life.

Malarial fever is a dreadful, world-wide disease. If you look at the map in a medical geography, you will see that the whole space between 40 degrees north and 30 degrees south is flooded with malarial fever, with the exceptions of dry Australia, the dry western states of the United States, most of Arabia, and Egypt. In some localities almost the whole population is sick with the fever, like many places in Africa, Central and South America, Indo-China, the lowlands of India, and so on. There are in Africa many places where malarial fever kills in 48 hours if medical help does not come in time. Many of us remember a bold challenge of Ravanalona, queen of Madagascar, to the French Government: "I have very few soldiers, but my fevers will decimate your armies very efficiently!"

Millions are sick with malarial fever in acute form, millions are sick with the same fever in chronic form (paludism), and other millions are suffering from blood-sucking mosquitoes. All these sufferings are dispensable. The causes can—and must be—exterminated, eradicated. I know what malarial fever is, for I was sick with it during 19 years.

In fairy tales the treasures are often guarded by colossal genii, immense dragons, powerful goblins, but the treasures of the tropics are guarded by tiny fairies—mosquitoes. They are small, the smallest of them being almost invisible, but they perform their duty wonderfully well. They sting, annoy, and irritate; they poison with the germs of malarial fever, yellow fever, filariosis, elephantiasis, and what not.

The fight between men and mosquitoes is very old and until quite recently the mosquitoes were the conquerors. Some scientists are of the opinion that malarial fever—in other words, mosquitoes—greatly contributed to the downfall of the Roman Empire. At last the scales begin now to turn to man's side. Since the discovery of Sir Ronald Ross, in 1897-'98, that mosquitoes are the propagators of yellow fever and malarial fever, men have begun to fight them more energetically. The Americans have developed quite successful methods,



Courtesy of the United States Bureau of Entomology

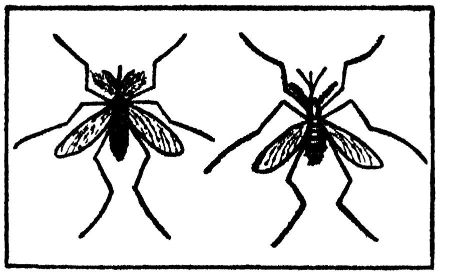
A MOSQUITO BREEDING POOL IN DALLAS, TEXAS

Oiling and draining have greatly reduced malaria, but the author of the accompanying article feels that the attempt thus to cope with malaria will prove impossible of general attainment which were demonstrated conspicuously at the Panama Canal and in cities of Ecuador and Brazil, the larger cities of the latter country being now almost completely free from mosquitoes and from the fevers.

UNFORTUNATELY these simple and effective measures can not be applied to rural conditions. The main reason for the impossibility is this: In the city every receptacle containing water can be inspected and protected from mosquitoes by wire nets, oil, emulsion, or fishes that eat mosquito larvae. In the country, especially during the rainy season, every small cavity and hole in the ground—imprints of the hoofs of animals, for example—contains water and serves as a breeding place for mosquitoes. Dr. L. O. Howard of the United States Bureau of Entomology relates the observations of W. E. Howorth in Tanganyika, Africa, that mosquitoes even breed [illegible] in the crowns of cocoanut palms. He also cites several authors who observed breeding mosquitoes in tree holes, in cocoanut husks, in the hollows of bamboo stumps, and so on.

Thus it has so far been impossible to free rural localities from man infesting mosquitoes, and therefore from malaria. With the methods which I have the boldness to offer it should be possible.

When Sir Ronald Ross propounded a theory that malarial fever is propagated by mosquitoes, almost everyone laughed at him. Even General Gorgas laughed—the same Gorgas, who, afterward, having adopted the Ross theory, put it into practice with such success in Panama, making it possible to dig the Canal.



Drawings reproduced by permission from the 1929 Edition of the "*Encyclopedia Americana*."

ANOPHELES

The *anopheles* mosquito carries malaria; when it alights its body slopes sharply

"The world requires," says Ross, "at least ten years to understand a new idea, however important or simple it may be. The mosquito theorem of malaria was at first ridiculed, and its application to the saving of human life treated with neglect, jealousy, and opposition."

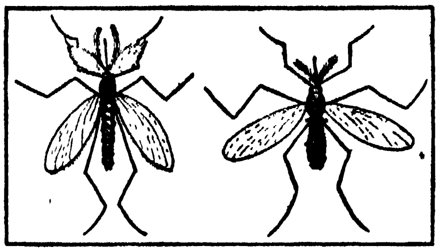
I offer a plan to free the world from malarial fever and from human blood sucking mosquitoes. It is possible that my plan will be also ridiculed. It is, however, so easy to put into practice, so certain to produce the desired results, that I am sure in less than ten years every planter and every farmer, even the least instructed, will make use of it. The use of this plan will assist the tropics in working out their inexhaustible riches.

Thirty-five years ago I lived in the village of Machindjauri, District of Batum, Caucasus, Russia. I noticed that out of 60 inhabitants of the village every one was sick with malarial fever, except four—Sahli Effendi, his wife, and their two children. Analysis of the conditions showed me that Sahli Effendi differed from the other inhabitants of the village only in this: he raised beans for sale in the market at Batum, and alfalfa for his horse. The beans and the alfalfa were grown around his house.

ANOTHER instance. One summer, when malarial fever was raging in Machindjauri, I moved my family to Kvishhety, near Suram, on the Transcaucasian Railroad. This village consists of two parts. The larger part is situated on the slope of a mountain. It is free from malarial fever. The smaller part is situated in the valley of the Kura River, and has a good deal of fever. One of the inhabitants of the lower part of this village, Misho Kipiani, sowed about six acres to alfalfa. As soon as the alfalfa grew up and began to bloom, malarial fever disappeared as if by magic!

These two cases were a point of departure in building my plan of attack. It is known that mosquitoes feed on the juice of plants; the males feed exclusively thus, and the females feed partly on the juice of plants and partly on the blood of animals and men. I found that when *Anopheles*, the malarial fever mosquito, feeds on leguminous plants, their juice neutralizes the noxiousness of the mosquito. It can no longer spread malarial fever. A locality known as the Marshes of Kará-Su (Black Water), near Tiflis, Caucasus, was uninhabitable on account of malarial fever. But the government performed some drainage, people began to come and to sow alfalfa, as alfalfa was in great demand on the Tiflis market, and malarial fever began to diminish. Local scientists and physicians ascribed this diminishing simply to the drainage and the clearing of the underbrush, but *Anopheles* still was present there as before. Many of the mosquitoes were, however, being neutralized by the juice of the alfalfa, and could not spread malaria.

When I was appointed Russian Government Agricultural Commissioner to the United States I had to travel a good deal. Incidental to my special agricultural work, I continued my observations pertaining to my belief. I spent one summer in the southern states, and here I found many facts that confirmed it. I am sorry to state that all my materials—notebooks, photographs, and so on, perished during the Russian revolution and my flight from the Bolsheviks, but I remember several facts like the following. In the midst of the marshes of Arkansas I found a little farm which belonged to an old man. He and his family were well, while all the people around were sick with malarial fever. The cause of this seeming immunity was clear. Beside a field of cotton he had, near his house, a field of alfalfa. His neighbors had only cotton fields.



CULEX

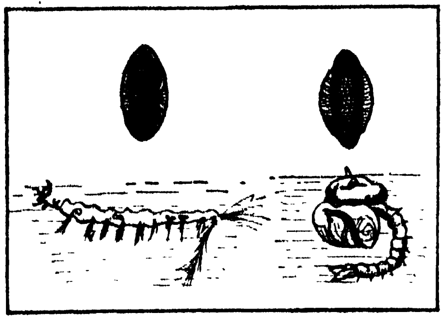
The common culex mosquito carries no malaria; its body rests horizontally

In 1911 I was sent by the Russian Government to Argentine to study some agricultural problems. I was greatly impressed with the remarkable extension of alfalfa growing in that country. Inquiries showed that as soon as alfalfa was sown in some malarial locality, the fever disappeared there at once. Just as in the Caucasus, the inhabitants of the localities explained the disappearance of malarial fever by the fact that these places were cleared. They were cleared, but the mosquitoes were present there as before, but now they were "sterilized" and could not inoculate human beings with the disease.

IN 1912 I was transferred from the Russian Government Agricultural Agency at St. Louis to the Department of Agriculture, Petrogad, Russia. In the summer of that year I was sent to Turkestan, Central Asia, to teach the farmers the California method of fruit drying. Here I also found innumerable facts in support of my discovery. Wherever there was alfalfa among the orchards and vineyards there was no fever; wherever there were only orchards and vineyards there was fever.

My good friend Mr. I. N. Klingen, former Principal Agriculturist of the Imperial Domains (Udély) in Russia, has communicated to me that by his order in the estates of the Grand Dukes, situated in the districts (*gubernii*) of Orel and Tambov, 60,000 acres were planted to red clover. Previously these localities had many cases of malarial fever, but as soon as clover grew up, malarial fever disappeared there completely. Clover, like alfalfa, is leguminous. Alfalfa, clover, beans—all these and numerous others belong to the leguminous family and have in common a substance called coumarine. "May coumarine play a rôle in the insects comparable to that which quinine plays in man," says the prominent Yale scientist d'Herelle.

The English edition (1924) of d'Herelle's book, "Immunity in Natural Infectious Disease," contains further confirmation of the theory. On page 187 the author says: "The greater portion of the Argentine Republic is completely free of malaria, in spite of the fact that the *anopheline* carriers abound in these regions where very frequently are to be found human carriers of the plasmodia, who have contracted the disease in the malarial districts."


ANOPHELES
Above: the eggs (top and bottom). Below: the larva or "wiggler;" at right, the pupa

Further, Dr. d'Herelle states, "We have seen that in all of the free regions there is a wild plant . . . called by the natives *'trebol de olor'* (scented clover), belonging to the genus *Melilotus*, probably a local variety of *Melilotus altissima*.

"FLOWERING takes place during the critical period of malaria, that is, from the beginning of summer to the end of autumn. The highly scented blossoms are continually frequented by insects of many kinds, and particularly by *Anophelines*, which feed upon the juice which, like all plants of the genus, contains a glucoside, coumarine. This plant is not present in malarial districts."

On page 188 we read this: "Recently, while living in Holland, I have sought the cause of the disappearance of malaria, as has been noted for about 20 years, from certain islands of Zealand and from northern provinces of Holland. In these two regions the disappearance of malaria coincided with the accidental introduction of plants of the genus *Melilotus* . . . Malaria has, on the contrary, continued to ravage certain of the Zealand islands where . . . the *Melilotus* has not been introduced."

I was equally much pleased to find in the *Literary Digest*, Volume 98, Number 4, page 17, the following abstract from the pamphlets of Sir William Willcocks, engineer of Cairo, Egypt: "Cultivated Egypt is mainly immune from malaria, and cultivated Egypt means Egypt with all its wealth of clovers, leguminous plants, wild melilotus, and trigonella. But where tracts of Egypt have been planted with fruits or other crops instead of clover, there malaria devastates the population as it does in Palestine and Greece, where there are few leguminous crops and in those parts of India where *gram*, a kind of chick-pea, is not cultivated."

You see that all three of us came independently to the same conclusion. And all three of us have traveled widely so that we could observe the confirmations of the theory in different localities of Europe, Asia, Africa, and America.

All this gives me a support to an affirmation that my theory could be applied *consciously* in any malarial locality, as it was applied *unconsciously* in the localities mentioned above. We can introduce leguminous plants, with the intention of disinfecting *Anopheles*, the malarial mosquito, either as fodder, as manure, or as decoration. Some of these leguminous plants are flowers and some are large, shady trees, but all of them have, as is well known, the property of gathering nitrogen from the air by means of the nodules on the ends of their roots.

THIS is the first part of my plan. The second part consists of replacing mosquitoes which suck the blood of human beings by mosquitoes which suck the blood only of animals.

In the *Comptes Rendus de l'Academie des Sciences*, Paris, France, for the year 1924, 1927*, and 1929, there are some very interesting articles by a French naturalist, J. Legendre. As he states, there are some mosquitoes that do not sting men. There are also some mosquitoes whose larvae eat the larvae of another mosquito, and in this way exterminate them from a given locality. M. Legendre has discovered in Brittany a mosquito—he calls it *Breton culex*—which crowds out another breed of *Culex* mosquitoes, and at the same time does not sting men but only animals.

In July 1923, M. Legendre transported eggs and larvae of *Breton culex* from the place of its habitation to Pons, where swarms of *Culex pipiens* and *Culex hortensis* annoyed the people. In the summer of 1924 M. Legendre did not find these mosquitoes there. They were replaced by *Breton culex*. These mosquitoes, hatched in proximity to the habitations, did not sting children or adults but only chickens and probably wild birds. M. Legendre continued his observations in 1928, and found out that *Breton culex* had held its own, and continued to be "man-hating" in the new locality.

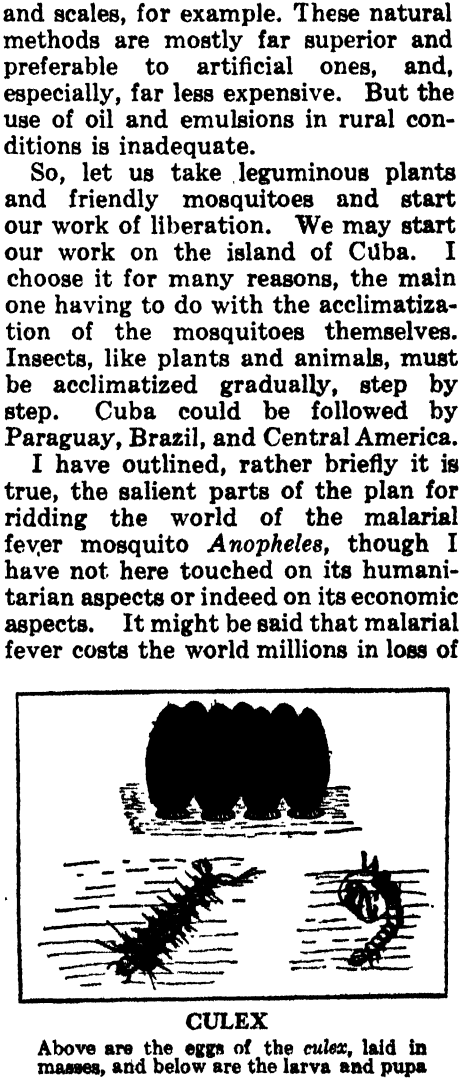
A proprietor of a farm near Pons asked M. Legendre to free him from annoying mosquitoes. M. Legendre introduced his *Breton culex*, and in one month they crowded out the aboriginal mosquitoes.

M. Legendre also discovered in several localities in France a variety of *Anopheles maculipennis* mosquito which does not sting men. Curiously enough, these mosquitoes and *Breton culex* live together in some localities as good neighbors, having no tendency to crowd one another out. M. Legendre thinks it would be well to introduce both of these races into localities where there are malarial fever and human blood sucking mosquitoes.

While the first part of the proposed method—the use of leguminous plants—is a novelty, the second part is a new departure from the ordinary use of insects to fight other insects which are injurious; lady birds against aphis and scales, for example. These natural methods are mostly far superior and preferable to artificial ones, and, especially, far less expensive. But the use of oil and emulsions in rural conditions is inadequate.

So, let us take leguminous plants and friendly mosquitoes and start our work of liberation. We may start our work on the island of Cuba. I choose it for many reasons, the main one having to do with the acclimatization of the mosquitoes themselves. Insects, like plants and animals, must be acclimatized gradually, step by step. Cuba could be followed by Paraguay, Brazil, and Central America.

I have outlined, rather briefly it is true, the salient parts of the plan for ridding the world of the malarial fever mosquito *Anopheles*, though I have not here touched on its humanitarian aspects or indeed on its economic aspects. It might be said that malarial fever costs the world millions in loss of productivity alone, but a definite estimate would force us to talk in terms not merely of millions but of billions.


CULEX
Above are the eggs of the *culex*, laid in masses, and below are the larva and pupa

I hope that among 120,000,000 Americans there will be found one who can lend a helping hand to this enterprise.

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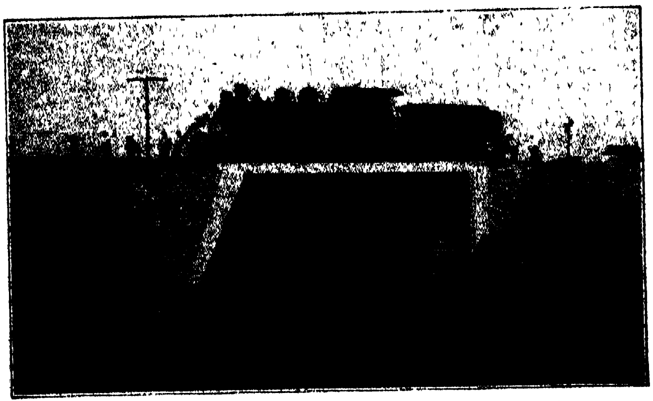
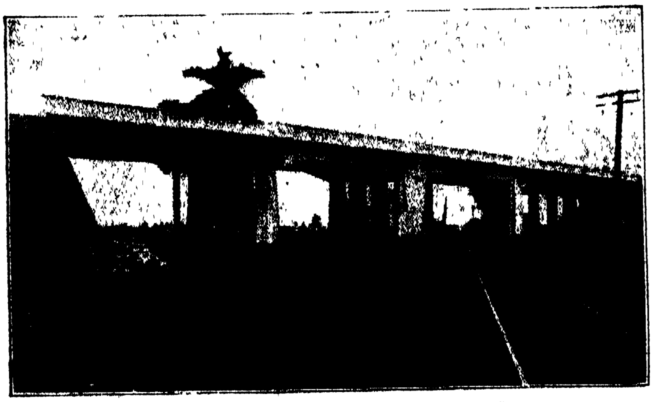
*The article of 1927 was abstracted in the *Literary Digest* for March 31, 1928.



THE NEW HIGHWAY AT AN UNDERPASS

The sub-grade is surmounted by 12 inches of heavy rock, then a layer of concrete from six to nine inches in depth. This is topped by a two-inch bitulithic covering of special composition



ONE OF THE 25 OVERPASSES

Outside the towns, the highway is about 20 feet in width with a 5.64 foot shoulder on either side. In towns the width is about 26 feet. Note the massive construction for withstanding storms

Cuba Builds a Model Highway

Work Is Progressing on This 700-Mile Highway, in Which All Grade Crossings Are Eliminated

By HAMILTON M. WRIGHT

CONSTRUCTION on the 700-mile Cuban Central Highway is now 59 percent completed, according to W. C. McDonald, manager of the Cuban operations for Warren Brothers Company, of Boston, which is constructing 500 miles of the road. The remaining 200 miles, in the Matanzas and Santa Clara provinces, are being constructed by the Associated Cuban Contractors, Inc.

One of the outstanding features of this arterial highway is that there will be no intersections with railroads. It is believed to be the only great national highway on which grade crossings have been eliminated entirely. In seven instances, the highway passes beneath the railway tracks, and in 25 it crosses above them.

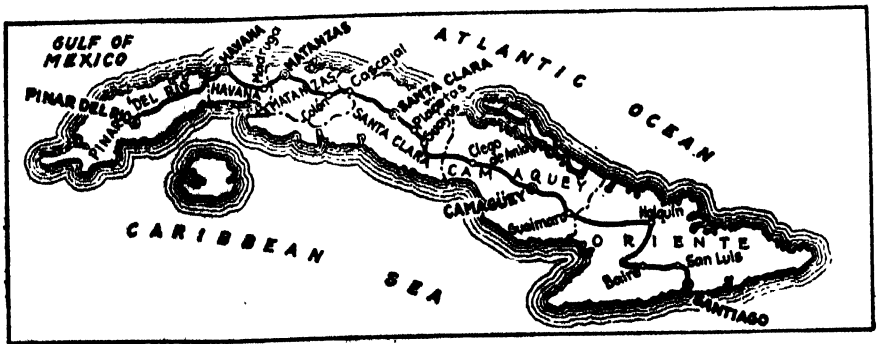
There are no grades exceeding 5 percent, and no turns with more than 4 percent curvature. A large number of costly fills and cuts have been necessary to maintain a direct route in the rugged country traversed. The total cost of the road was originally estimated at 75,680,000 dollars, but extensions since authorized have raised the cost to approximately 100 million. Already about 60 million dollars has been expended.

Approximately 11,000 men are employed in the winter season, when the work is not hampered by torrential rains. Of these, about 8000 are employed by Warren Brothers Company. This firm has introduced about 2,500,000 dollars worth of road-making equipment.

At present it is possible to ride about 75 miles east or west of Havana on the new highway. It is expected that the road from Havana to the city of Pinar del Rio will be opened on May 20th, the 28th anniversary of the establishment of the Cuban Republic. It will also be open from Havana to Santa Clara by that time, according to expectations. In the summer of 1930, the road is scheduled to be open from Havana to Camaguey. Mountainous sections of the road in Oriente Province have been completed, but the final opening of the road to Santiago de Cuba will probably occur late in the spring of 1931.

FLOOD PROTECTION ➤

This Tilford rock fill at Madruga passes over a valley which often is flooded



CUBA'S NEW HUNDRED MILLION DOLLAR HIGHWAY

This great highway follows the "backbone" of the island nearly from end to end. It will provide an outlet for 185 sugar plantations, and passes through country noted for its magnificent tropical scenery. American motorists will reach Cuba by ferry-boat from Key West

The Two April Eclipses

Astronomers Will Make Full Preparation, Even Though the Coming Solar Eclipse Will Last Only Two Seconds

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE month of April is notable for the occurrence of two eclipses, one on the 12th-13th and one on the 28th, both of which are visible throughout the whole extent of the United States. The first is a partial eclipse of the moon which happens on the night of the 12th and early morning of the 13th. At this time the moon passes far to the north of the center of the earth's shadow, so that only one ninth of her diameter is immersed in it, even at the greatest phase. Were her track only 250 miles higher above the plane of the ecliptic she would escape eclipse altogether.

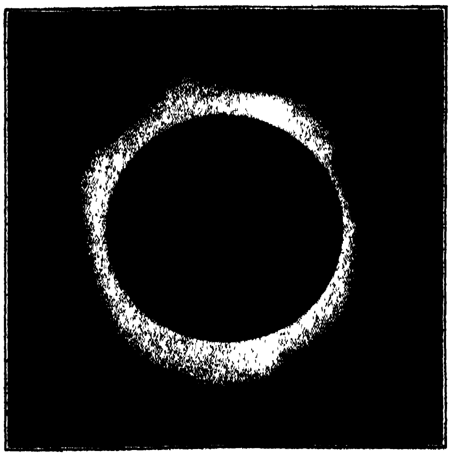
The moon enters the penumbra of the earth's shadow at 10:43 P.M., Eastern Standard Time. At this moment an observer at the proper point of the moon's surface, on what looks to us as her southeastern edge, would see the earth just begin to trespass on the sun's disk and cut a small notch in it. The terrestrial observer watching the moon will notice nothing at all, for at this first moment the brightness of the sunlight which illuminates the moon will be decreased by only an infinitesimal amount. Half an hour or so later, when the earth has hidden a considerable part of the sun from our hypothetical lunar observer, the gazer from the earth may notice that the southeastern side of the moon is not as bright as the rest, and before midnight this change will be conspicuous.

FINALLY, at 12:21 A.M. on the 13th, the moon's edge reaches the true shadow or umbra. For a lunar observer at this point the sun would disappear behind the earth, while the terrestrial watcher will see the dark shadow beginning to cut a notch in the moon's limb. To the naked eye the edge of the shadow seems sharp, but a field glass, and much more a telescope, will show that it is hazy and indefinite. This is natural since it is the shadow of the earth's atmosphere and not of its solid surface.

On the present occasion when only a small part of the moon's edge is shadowed, the obscured portion will be almost invisible, but this is mainly an effect of contrast with the bright part of the disk. In eclipses of greater magnitude, and especially in total eclipses, the whole body of the moon remains visible, illuminated faintly by light which has been reflected by the earth's atmosphere—just as a concave lens bends light inward. Our imaginary lunarian would at this time see the earth rimmed by a narrow but brilliant line of light, brightest at the point on the edge which was nearest to the hidden sun, tinged with the colors of the sunset, interrupted here and there by gaps where clouds impeded the free passage of the rays. Little of this will, however, be visible at the present time.

ECLIPSE RECORD-HOLDER

Professor J. A. Miller, Swarthmore astronomer, has never lost an eclipse because of cloudy skies. Nine times he has journeyed to witness total eclipses—nine times been rewarded. Other astronomers, joking, perhaps envious, accuse him of having a "pull" with the weather



ECLIPSE OF 1929

Taken with the Navy's telescope camera, Philippines, May 9, 1929. Furnished by Theodore Michelson, one of our readers

At 12:58 A.M. the eclipse area reaches its maximum and at 1:36 the shadow withdraws. The moon is not out of the penumbra until 3:15 A.M. but the last stages of its exit, like the first of its approach, will be imperceptible.

Of much greater interest and importance is the solar eclipse of April 28th. This is described in the *Nautical Almanac* as a "central" eclipse, since it is total at some points along the shadow track, and annular in others and can not therefore be called by either name.

It may be remembered that when the moon is nearest the earth her shadow extends beyond us. When it strikes the earth's surface it forms a small dark spot, never more than about 160 miles in diameter, from which all sunlight is excluded (Figure 1). An earthly observer anywhere within this region will see at the given moment the moon completely hiding the sun and outlined black against the corona.

BUT if the moon is farther off than the average her shadow tapers to a point before it reaches the earth, and there is no point on the earth's surface from which all sunlight is cut off. An observer right in line with the moon and sun will see the former centered exactly on the latter but exhibiting a smaller disk, so that a narrow bright ring of the sun sticks out all around and produces an annular eclipse. (Figure 2).

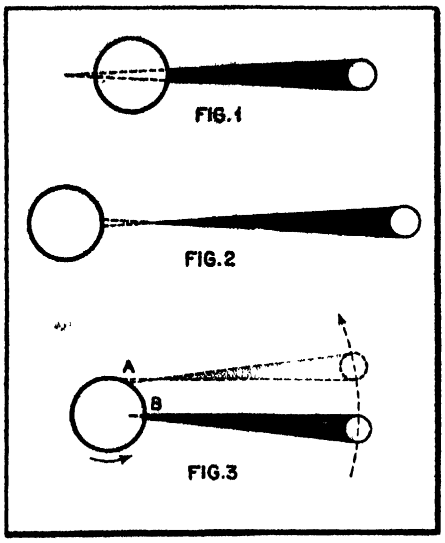
Once in a while, however, the moon's distance may be intermediate, so that the point of the shadow falls short of the earth's center but is nevertheless able to reach its surface which is almost 4000 miles nearer. In such a case an observer on the central line near the ends of the shadow track (A in Figure 3) will see an annular eclipse, while for one at B, near the middle of the path, it will be total. This is what happens on the 28th. The tip of the shadow cone reaches at most only about 70 miles beyond the earth's surface, so that the eclipse is annular over most of its course but total for a small part in the middle.

Starting far out in the Pacific the line of central eclipse passes some 500 miles south of Hawaii. The eclipse becomes total shortly before its track reaches the Californian coast which it attains at a point about ten miles north of San Francisco. Its motion here is almost due northeast and takes it diagonally across northern California, northwestern Nevada, the southeastern corner of Oregon and through Idaho and Montana into Canada. Shortly after crossing into Montana the eclipse loses its total character and the annular phase is visible along the rest of the track which crosses Hudson Bay and Labrador and leaves the earth in the Atlantic south of Iceland and west of Ireland.

A partial eclipse can be seen in a wide belt on each side of the central line extending northward to Alaska, Siberia, Greenland, and the Pole, southward to Yucatan and Cuba and eastward to Scotland and Ireland where the sun sets eclipsed.

THE magnitude of the greatest eclipse is of course more than 99 percent at San Francisco and is more than 80 percent along the whole Pacific Coast from Seattle to San Diego. Chicago sees a maximum eclipse of 64 percent, New York 54 percent, New Orleans 30 percent, and southern Florida only half as much.

The total phase is longest in Nevada, but even there it lasts only a second and a half. The moon's shadow has tapered to a diameter of less than three quarters of a mile at a point where it reaches the earth, and this goes by very quickly. For the same reason the eclipse track is so narrow that great care will be necessary in picking out observing stations. In spite of this almost absurdly short duration the eclipse is likely to be well observed.



ECLIPSE OF APRIL 28

Figure 1 illustrates a common total eclipse, *Figure 2* an annular eclipse, and *Figure 3* peculiar conditions on April 28

Its track leads through a readily accessible country, near noon, when the sun is high, and it comes at a season when the chance of fair weather, especially in the Nevada deserts, is very good.

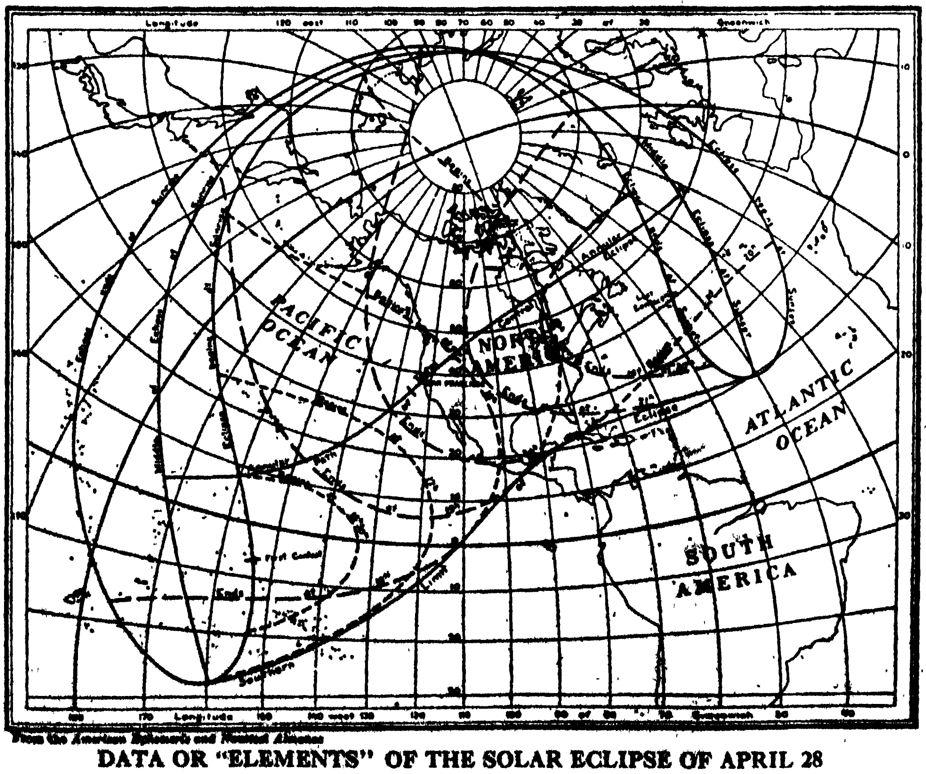
It may appear remarkable that anyone should go to the expense of a journey across the Sierras to spend less than two seconds in observation, but there are some problems for the study of which this eclipse is distinctly favorable.

At the moment of totality only the actual photosphere of the sun will be hidden—indeed it may even peep out here and there through the gaps between the lunar mountains. All the overlying layers of the sun's atmosphere will be fully visible, and spectroscopic observations taken with automatic photographic devices during the critical seconds may give data of much interest and importance.

Another problem which may well be attacked is that of the light of the part of the sun's disk close to its edge. It is well known that the limb of the sun is not nearly as bright as the center. To follow the fall of brightness up to within 1 or 2 percent of the distance from the center to the edge is not difficult, but in the last 2 percent of the distance the brightness falls off very rapidly and all sorts of complications arise when measures are attempted with a full sun. Scattered light in the instruments, and the trembling of the image due to "bad seeing," make the observations very troublesome. But, when the moon eclipses the sun, all that needs to be done is to measure the brightness of the remaining sunlight during the partial phases, and the problem is then one which the mathematician can easily solve. At the present eclipse the sun's light will fall off very fast indeed during the last few seconds before totality, and come back again with equal rapidity. Some automatic registering device, doubtless photographic, would have to be employed. If one is available we may learn much more than we know now about the brightness of the sun's edge; and this knowledge will be of much importance in testing the theories which are rapidly growing up regarding the sun's surface.

SO much for the professional observer. But will it pay the sightseer to go out of his way to look at this eclipse? Most assuredly. There will be time for only a fleeting glimpse of the corona. Indeed there may be so much light in the sky as to drown out all but the inner portions of it. But the advance of the shadow, coming like a narrow beam of blackness from the southwest, should be spectacular. At the crowning instant when it passes over in a "flash of blackness" the sun may appear as a ring of dazzling points of light interrupted by the mountains along the moon's edge. Something of this sort was seen at the last similar central eclipse, the track of which passed near Paris a year or two before the war. We may trust Californians not to miss the sight when they have the chance.

The location of the track along which this phenomenon was visible should fix with great precision the line of central eclipse, and this again will give precious information to the theoretical worker. All told, the eclipse will abundantly repay both the observer and the sightseer, and it is to be hoped that it will be well watched.—*Rome, Italy, December, 1929.*



From the American Ephemeris and Nautical Almanac

DATA OR "ELEMENTS" OF THE SOLAR ECLIPSE OF APRIL 28

The center line of the eclipse extends diagonally from lower left toward upper right. The other elements may be studied out from the drawing itself, by the especially interested reader

SITE OF THE EXPERIMENT IN RECLAMATION-FERTILIZATION

The irregular area outlined in white in the lower right hand corner is the Western Washington Hospital grounds. The arrow points to the small lake, the bed of which was covered with a heavy vegetable humus. Tacoma is in the haze of the background

Land Reclamation By Silting

Natural Humus Is Pumped, in Suspension, From Lake Bed Onto Gravelly Soil, Resulting in Extraordinary Fertilization

By CHARLES F. A. MANN

A UNIQUE and one of the most successful of the many reclamation schemes in use on the arid lands of the west was originated by Dr. Charles E. Taylor, superintendent of the Western Washington Hospital, located near Tacoma, Washington, on the farm lands of the institution.

This hospital, the largest operated by the State, was established shortly after Washington was admitted into the Union. Because of its proximity to the densely populated area bordering on Puget Sound, this location was chosen despite the fact that the entire area is part of an immense glacial moraine, left by a mighty glacier that at one time swept southwesterly down the slopes of Mt. Ranier-Tacoma and emptied its icebergs into the deep waters of Puget Sound. Cultivation of crops on the loose sandy soil of this area has long been a hopeless task, requiring excessive application of black dirt and water to form a soil that would nourish plants as well as hold moisture.

Some idea of this peculiar formation may be gained by consideration of the fact that one of the world's largest gravel pits is operated at tidewater, just two miles below the hospital, which is at an elevation of about 400 feet. Test borings indicate that this glacial deposit, on which part of the city of Tacoma, as well as the institution, is situated, is from 300 to 900 feet deep and of unusually uniform size. The sand is nearly all of white quartz-silica composition.

UPON assuming charge of the institution several years ago, Dr. Taylor at once set about to discover means to improve the general productiveness of the 700-acre farm operated by patients of the institution, from which a major portion of its food supply is derived. For years the institution had taken many prizes from its displays at local agricultural fairs, but these prize crops were all grown by a patient in his small garden situated near the shores of Waughop Lake, from whence comes the irrigation water supply used during summer months. Dr. Taylor found that this man was mixing his garden soil with a blackish pasty substance which he dug from the shores of the lake when excessive pumping had lowered its surface during summer months.

Tests of the composition on this deposit showed it to be a pure vegetable mold, of bluish green color, that had been accumulating for centuries on the bottom of the lake. Since its decay had taken place under water, practically all of its mineral content had been retained. It is of almost powdery fineness, a small quantity shaken with water requiring over 30 hours to settle out. In its lower strata it took the formation of a thick vegetable jelly. Tests with iron piping driven into the bottom showed the deposit to be nearly 200 feet thick.

Tracing the course of the glacial moraine, scientists have found it to be about 24 miles wide at its widest part, running inland into the rocky foothills of Mt. Ranier-Tacoma for a distance of about 45 miles. The sudden termination of the deposit in these foothills is explained by the fact that the 14,408-foot volcanic cone was at one time about 3000 feet higher; a gigantic explosion, which must have made the explosion of Krakatoa in Java Strait in modern times a puny affair, scattered the entire top and its masses of ice over a very wide area. Because of the heavy precipitation on the mountain and the higher altitude of the older cone, the ice-pack was forced clear to tidewater, carrying its burden of pulverized rock and sand with it. At the present time many small lakes are scattered over its surface, yet only in very recent times have scrub oak and the persistent Douglas Fir with its flat, fan-like root structure, gained a foothold on the loose sandy soil.

Traces of the one-time glacier have manifested themselves in freakish ways throughout the area. In the northern part of Thurston County there is an area of ground covered with peculiar mounds of gravel. On the soil of these mounds, for the presence of which no explanation can be made, only buttercups and coarse grass grow for a short while each spring, although on the heavy clay of Tacoma nearby, plant growth is luxuriant the year 'round.

After careful study, Dr. Taylor found that many of the lakes over this section had similar deposits of the soft mold, which accounted for water remaining on the sandy soil. It is commonly believed by people living on the shores of these lakes that any attempt to drain the lakes in order to remove snags and stumps will break this seal and ruin the property. Real-estate developers are always poetic about describing the virtues and picturesqueness of the snags and stumps, so the lakes are never drained for cleaning.

PUMPING THE FERTILIZING MUCK

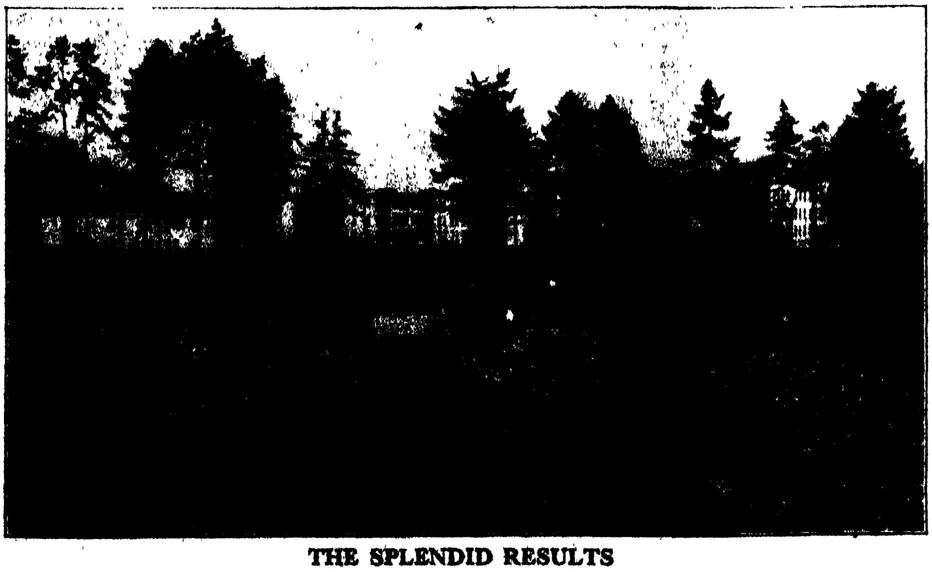
When the lake was drained, it was found that the bed did not dry out because of several springs. This pumping station was installed to pump the humus-filled water over the land

IF small-scale use of this deposit as fertilizer and binder was successful, why not use it on a large scale and test its merits on a public farm? Thus would be proved for the small farmer the possibility of using land that is not worth over 25 dollars per acre for crops in its present state. Dr. Taylor also wondered whether the lake, which is about 30 acres in extent, was not fed by springs instead of merely being a drainage pocket for rainwater. Accordingly, plans were made for placing the irrigation pump on a barge near the center of the lake.

Early in 1927 the pump was started, delivering 300 gallons per minute, and by autumn the lake was dry. The object was to expose the mud until it was hard enough to shovel out onto trucks. When the bottom was exposed it was discovered that three springs with an inflow of about 150 gallons per minute kept the bottom stirred up and continually wet. Tests of the fresh mud rising to the surface showed that it was fine enough to be pumped through the entire irrigation system, even through sprinklers with quarter-inch nozzles!

With one stroke it was possible to eliminate expensive hauling of the heavy black dirt from the valleys below and to irrigate the land and spread the mud which both sealed the loose sandy formation and fertilized it at the same time—all in one operation. The swiftly revolving blades of the centrifugal pump, which was driven by a 12-horsepower motor, using current costing nine cents per hour, helped to mash the small lumps of the blue ooze. Soon the material was pouring over the fields through sprinklers and irrigation ditches at the rate of 150 gallons per minute. It had the consistency of thick pea soup. The water soon filtered into the sand, leaving the fresh humus to mix with the topsoil. Steady flow of the springs during the year made it possible to spread a four-inch deposit on the entire farm. Dr. Taylor points out that there is still no explanation for the existence of vegetable matter in the lake unless it was caused by the constant drifting of grass and leaves which dropped into the three-sided pocket.

To the astonishment of agriculturists at the Western Washington station in Puyallup, three crops of alfalfa were grown on a field during 1928. Puget Sound climate was supposed to be bad for this crop, with most of its growing centered in the volcanic ash soils of eastern Washington. Cabbage was grown where even fir trees previously had a hard struggle. Celery grew three feet high last year, on soil that formerly would not support plain grass. In 1927, 13 acres devoted to corn yielded 148 tons. In 1928, over 200 tons came from the same patch. Costs for fertilizer and soil hauling were cut to a quarter those of former years, and with increased yields. Rutabaga turnips for stock feeding reached 10 to 16 pounds in size.



THE SPLENDID RESULTS

In the foreground is a fine growth of cabbage on sandy soil that, previously, was practically worthless. The firs were planted 40 years ago and won't grow higher due to sandy soil

THE success of Dr. Taylor's experiment has attracted wide attention throughout the northwest and it is believed that further projects will be undertaken to utilize the properties of this vegetable mold that is so widely deposited in western mountain and hillside lakes. Costs are limited to pump, power, and labor for digging ditches or running pipelines. Countless thousands of level prairies that are adjacent to lake deposits such as this, are scattered over the west. Application of water alone to these areas would be without result, but the practicability of obtaining this vegetable humus from these natural storehouses and supplying it to the soil, would open up an entirely new field for application of the principles of reclamation on a restorative scale.

What Mummies Reveal

X-ray Studies of Peruvian Mummies Show Us the Injuries and Diseases From Which the Ancient Civilized Indians Suffered

By ROY L. MOODIE, Ph.D.*

One-time Anatomist, College of Medicine, University of Illinois

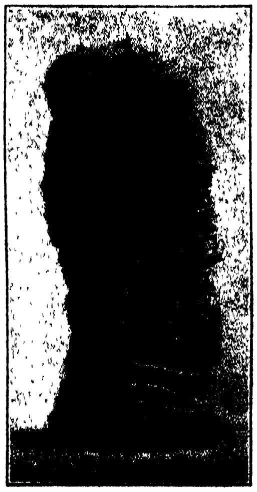
AMERICAN mummies have never received the attention accorded those from Egypt. They are neither so ancient nor so numerous as those found along the Nile, nor did mummification in the Western Hemisphere have such an important influence on the daily life of the people as it did in the land of the pyramids for thousands of years. During that period the elaborate embalming processes and the preparation and care of the tomb developed into a widespread industry which furnished employment for a considerable part of the population, including many of high professional training.

Mummies of one kind or another are known from isolated areas throughout that vast stretch of territory extending from Alaska to Patagonia, but are confined largely to the Pacific Coast. Nowhere in this area, however, did the preparation of human mummies attain the height it did in Egypt. There all of the sacred animals were also embalmed. This provides us with quite an insight into that country's vertebrate fauna. No animal mummies were prepared in the Americas.

THE nearest approach to the Egyptian mummification of the human dead was that which developed within the boundaries of pre-Columbian Peru, the empire of the royal Incas, where for hundreds of years great care was shown in the preparation of the dead. Recent studies of the ancient Peruvian mummies by the microscope, by the X ray, by the study of the dry bones of disrupted mummy-packs and by a search into their surroundings, have revealed a great deal of interesting information regarding the life of those times when the mummified bodies were the actors of life's drama.

MUMMY PACKS

The packs served as coffins, there being no further protective covering. The one at the top, 33 inches long, is of plaited straw



It is said by early writers that great care was exercised in the preparation of the dead of the Inca household and that the mummies were brought out on feast days to share in the favor of their superior beings. Yet not one single royal mummy from ancient Peru is known today. This is in the greatest contrast to the royal mummies of Egypt. A large folio catalog is required to contain the descriptions of those preserved in the Cario Museum.

Little is known about the preparation of mummies in pre-Columbian Peru. We are pretty sure that the body was never opened for this purpose, as it commonly was in Egypt, yet there were skillful surgeons in Peru. Embalming materials, such as resins, astringents, gums, and so on, were known in early Peru, but we are not sure whether they were used. Sun-drying was probably the most common method.

The greatest care was often exercised in the preparation of the mummy wrappings. Often, on the other hand, this was carelessly and heedlessly done. The sarcophagus and the coffin were unknown, nor were the tombs so elaborate as in Egypt. Many of the Peruvian mummies, after careful wrapping, were buried in the sands of the desert, or placed in fissures, in shallow recesses, or in deep caverns. Nowhere in Peru was a tomb chiselled from the rocks, although they did employ certain pyramid-like structures built of mud bricks.

THE wrappings, of beautifully woven and decorated cloth, of dressed skins, feather blankets, or of coarsely woven materials and even of native grasses, do not display the complicated arrangements and writings of Egypt, nor do these materials ever indicate foreign trade. But they do connote some degree of commerce between the coastal and mountainous regions of ancient Peruvian times. The colors of bird feathers such as those of the flamingo and of the macaws are perfectly retained after resting for a period of many centuries in the desert sands.

The mummy packs of Peru are unlike those of any other area. Often the huge bundle, gorgeously decorated and elaborately equipped, shows a false head, with features indicated by plaques of silver or other materials sewn on the face of the false head. One, two, or three bodies may be enclosed in the same bundle. Sometimes the X ray shows the mummy upside down in the pack. A pre-Columbian pack in Field Museum at Chicago contains father, mother, and child. Raw cotton, abundantly grown in prehistoric Peru, was used in quantities in the wrappings of the bodies. The greatest variety of appearances in the mummy-packs is found in different areas. A few of them are shown here.

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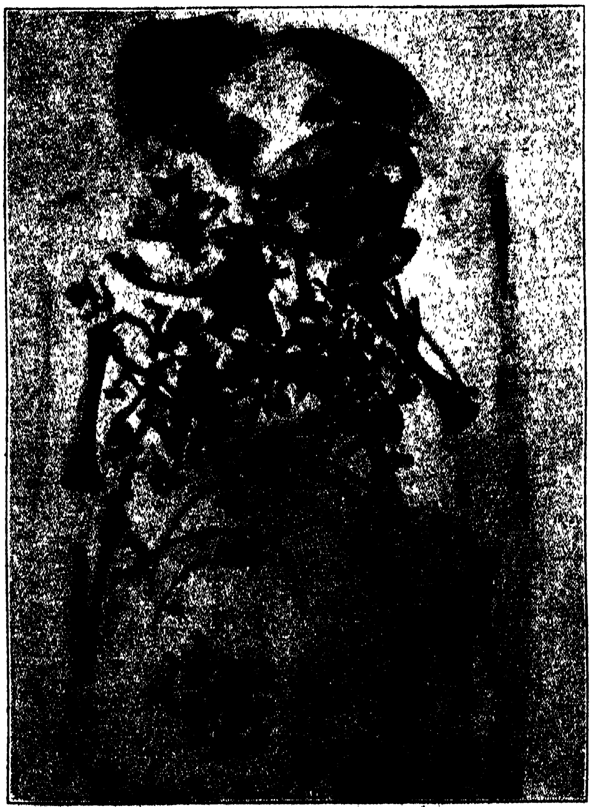
*See "Among Our Contributors," page 261.

The medical interest attached to the nature of these ancient mummies is very great. The X ray shows wide ranges of the diseases and injuries to the bones. The microscope supplements these findings by showing minute alterations in the walls of blood vessels, common to the hardening of the arteries. Diseases of the teeth are likewise revealed, and the evidence shows the ancient Peruvians to have been sufferers from many chronic ailments. A few of the mummies show trephinings of the head, a surgical procedure at which the pre-Columbian Peruvians were adept. It is a matter of surprise to learn how infrequently trephinings are found in the heads preserved in the mummy packs. This leads us to the query as to why trephining was so common in Peru.

The relief of pain due to depressed fractures of the cranium, following sling-shot injuries, was doubtless the greatest single cause of trephining, though of course there were other causes. The sling shot was the one most important single weapon of war. The slings were beautifully woven of wool, and were decorated. Hence they served also as an ornament to be wrapped around the head when not in use. The distance and accuracy with which rounded pebbles could be thrown is amazing. Since such injuries as depressed fractures were received more often by soldiers, it is thought that trephinings were done as a military measure to conserve the man power of the state.

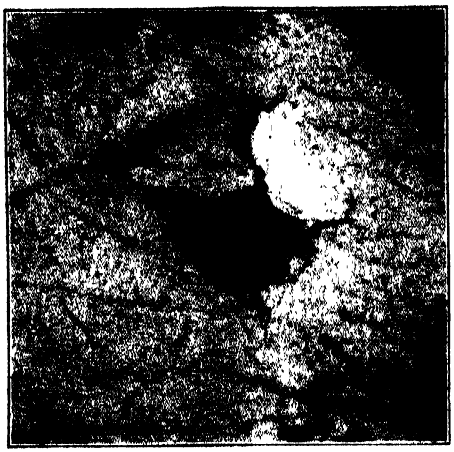


Courtesy Field Museum of Natural History

X RAY OF INFANT'S MUMMY

Usually in infant mummy packs the bones are greatly disarranged. The wrappings show in faint strands

The number of infant and youthful mummies is appalling. These often had received the briefest care, as shown in an accompanying figure. While our study of pre-Columbian pediatrics in Peru, as shown by the X ray, is still incomplete, yet it has gone sufficiently far to give us a fair cross-section of such maladies whose evidences would be visible in the skeleton, had they been present. Such a cross-section reveals an astonishing paucity of infantile troubles, showing a much greater degree of health than a similar cross-section of our own infant population would show. Rickets is surprisingly absent. Not a trace of it can be found. It is, of course, evident in these individuals that death was due to some digestive, febrile or other factor of neglect, having no effect on the skeleton.



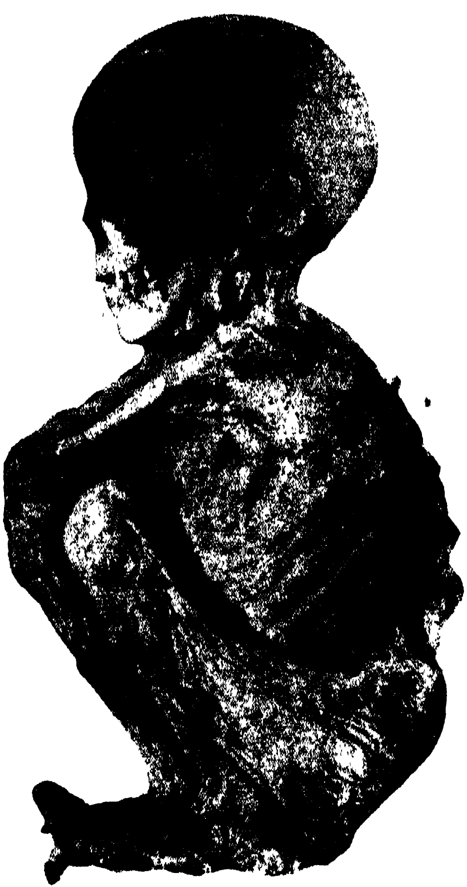
Courtesy San Diego Museum

INSTANT DEATH

Effect of impact of sling-shot pebble, seen from within skull of a child of eight

Vandalism has been the one most important factor in the loss of myriads of objects of the greatest archeological and anthropological interest, ruthlessly destroyed by treasure hunters throughout the ages. Egypt and Peru have shared alike in this. It is said that King Tut is the only royal personage of Egypt whose mummy had not been plundered. The Egyptian mummies had often been roughly broken up to secure objects of value. Similarly in Peru destruction has gone on, in spite of governmental mandates. We must read the story of the mummies from what is left of them.

Wrapped in the ancient mummy-packs are often found various ornaments, ears of maize, shells, dried food plants, packages of coca leaves, the native plant whose stimulating leaves commonly were chewed by the modern Indians. Associated with the burials are skeletons of the domesticated Inca dog and guinea pig. Thus we know what the food of these ancient people had been.



Courtesy San Diego Museum

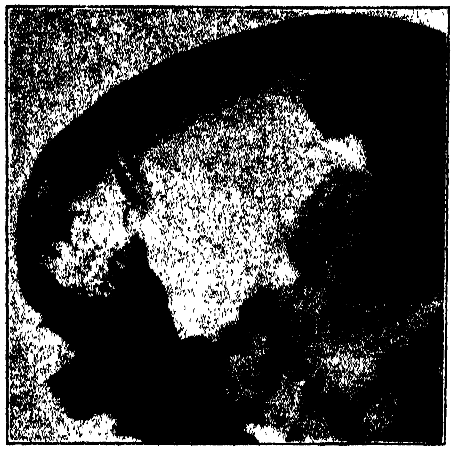
MUMMY OF AN INFANT

The tissues are well preserved and may be softened and examined microscopically

The nature of the ancient Peruvian mummies bespeaks a civilization which carried with it respect and care for the dead. Their woven and decorated winding cloths tell of a highly developed textile industry involving the agricultural care of the cotton and of wool-bearing animals, small camels which still serve the people of the Andes.

The religious motives underlying mummification in Peru are more obscure than in Egypt where the larger part of life was a preparation for the hereafter. We can but feel that we still have much to learn about those ancient folk whose mummies suggest unguessed thoughts and actions.

A STUDY of pre-Columbian pediatrics of Peru is now being carried on in Chicago at and by the Field Museum of Natural History where the large collection of prehistoric mummy packs of scores of infants and older children are being examined under the X ray. Some of the small mummies were simply dried and laid away without wrapping, as is shown in one of our illustrations. Unfortunately we are



Courtesy Field Museum of Natural History

HEAD UNDER X RAY

The skull shows the effects of a heavy smashing fatal blow from a metal mace

hampered in this study by the failure of the X ray to reveal all evidences of disease. This gap is to be filled, however, by examination of the bones themselves. These are to be found in profusion about the sites of prehistoric cemeteries in the coastal deserts of Peru and in caverns and rock shelters in the highlands.

IT is, of course, evident that we are restricted in our search for evidences of diseases to those which make a definite change in the skeleton. A study of the soft parts by the microscope has yet to be undertaken. Water on the brain, called *hydrocephalus*, in its advanced stages causing a perceptible swelling of a characteristic type, has been detected in a few of the infant mummies in Field Museum.

The commonest disease of ancient Peruvian children was a nutritional disturbance whose effects (see illustrations) are known as *osteoporosis*. It is thought that this disease does not occur in America at the present time; or if it does it is rare. There are scant evidences of its occurrence among ancient Egyptian children, but it was extremely prevalent within the past century among the children of the island of Socotra in the Red Sea. Its bony manifestations occur in symmetrical patches at the backs of the eye sockets, on the bones of the skull, inside and outside, but are not known elsewhere in the body.

Under the paternal form of government instituted by the Incas in pre-Columbian Peru, children were well cared for but even at that time life in the higher Andes was hard. The perpetual cold, scarcity of fuel, absence of any attempt at personal cleanliness and, doubtless very often, parental neglect, are all antagonistic factors to which were due the high infant mortality. The children were savages, of course, and adepts with the sling, so we may account for such fatal injuries as shown in one of the illustrations as the results of childish squabbles.

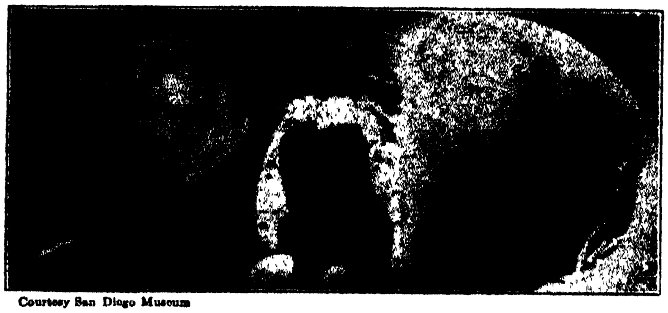
Although the surgical operation of trephining was extremely prevalent in pre-Columbian Peru, no child younger than 15 was ever operated on, among the many hundreds of trephined skulls which have been studied.

The teeth of the children in ancient Peru were usually sound and healthy. A few cases of cavity formation or dental caries have been seen in milk teeth. Shortly after the eruption of the permanent teeth, however, destructive processes were under way. Caries, pyorrhea, accompanied by huge deposits of tartar, abscesses, and other infections resulted in the loss of many of the teeth early in life and the loss of all of them later. Many an ancient Peruvian "gummed it" after he was 40 years of age. Only one perfect set of teeth from pre-Columbian Peru exists among a collection of 800 skulls in the San Diego Museum. Wisdom teeth seldom erupted and but four examples of impaction are known. No phase of dental surgery was understood or practiced in ancient Peru.

Only a beginning at pre-Columbian pediatrics has been made, but the progress already made is encouraging. A study of food substances in pre-Columbian Peru, now under way, will aid considerably in appreciating childhood life under the reign of the Incas and the pre-Incas of South America.

OSTEOPOROSIS

Osteoporosis or "bone porousness" was the commonest disease of childhood. The backs of the eye sockets are favorite places for this disease

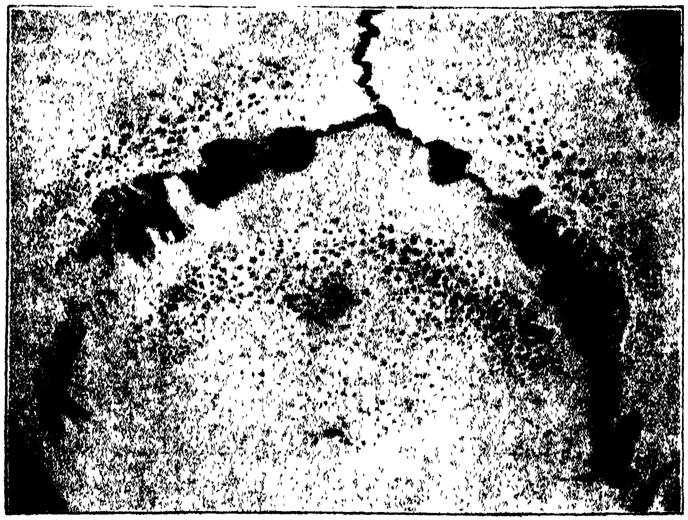


Courtesy San Diego Museum

Courtesy San Diego Museum

EXTINCT TOOTHACHES

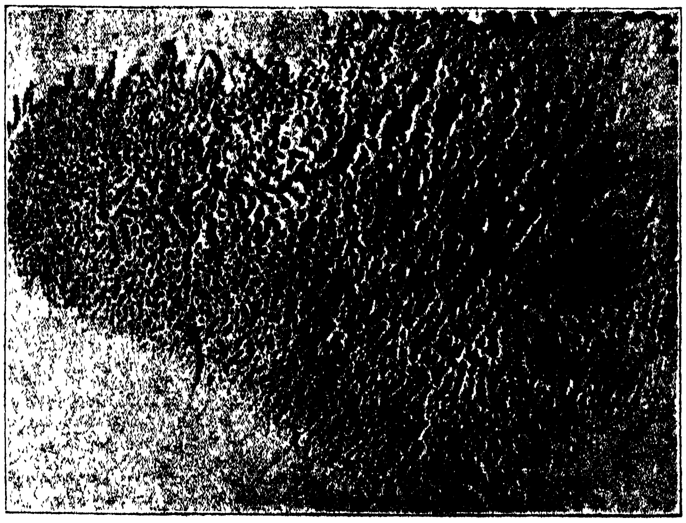
Milk teeth of children show cavities. Pyorrhea and abscesses were also common



Courtesy San Diego Museum

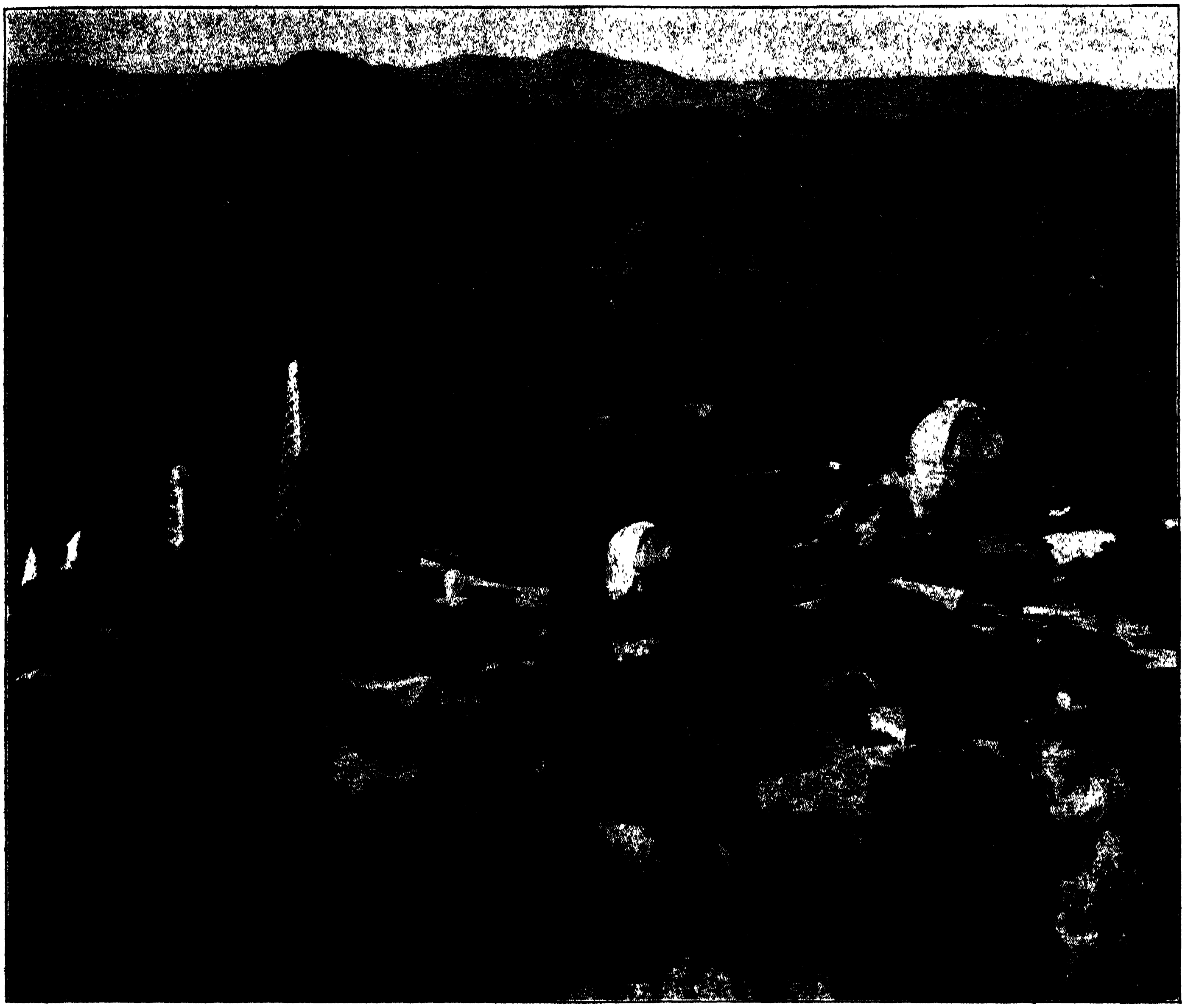
MORE BONE POROUSNESS

This is the top of a skull and shows the nutritional disease of osteoporosis along the wavy sutures or joint lines of the cranium



LACELIKE OPEN WORK—OSTEOPOROSIS

The disease results in patches of perforations. This child had reached the age of ten; the skin healed but the bone never closed



New Airplane View of Mount Wilson Observatory

FROM the vantage point of an airplane flying several hundred feet above the 5700-foot summit of Mount Wilson near Pasadena, California, one can obtain a clear impression of the famous Mount Wilson Observatory as a whole. The new photograph reproduced above was sent from Pasadena by one of the Corresponding Editors of this journal, Russell W. Porter, who is engaged in the co-operative project of the California Institute of Technology and Mount Wilson Observatory for building a 200-inch telescope and other equipment.

At the left is the long low structure of the Snow horizontal solar telescope. In front of its center is the 60-foot tower telescope, also for solar work, and near its end the higher powered 150-foot tower instrument for the same purpose. Nearer the reader and at the left edge of the picture the roof of a laboratory is partly visible through the trees. (The larger laboratory and the offices of the observatory are situated in the city of Pasadena). To the right is a reservoir and a comparatively small observatory dome which houses a six-inch refractor.

The two large domes are respectively those of the 60-inch and 100-inch reflecting telescopes. Between the large dome and the reader is the new Michelson-Pease 50-foot interferometer soon to be in operation. The entire housing for this refined instrument for measuring the diameter of the stars rolls off the instrument on a horizontal track.

"THE little cottage shown in the right foreground," to quote Mr. Porter's communication, "was built for the great astronomer Kapteyn, who occupied it for some time before his death. It is now used by the families of the observing staff and computers. Just out of the picture at the extreme left is the so-called Monastery where most of the astronomers live; also a hotel for visitors. The trees are pines, spruces, and live oaks; smaller growths are the manzanita and the yucca. Tame deer roam the observatory grounds unmolested. It is a hair-raising experience," Mr. Porter continues, "to come up the mountain by the narrow road in the big buses. If one car meets another the rule of the road requires that the one coming down must back up to a turnout.

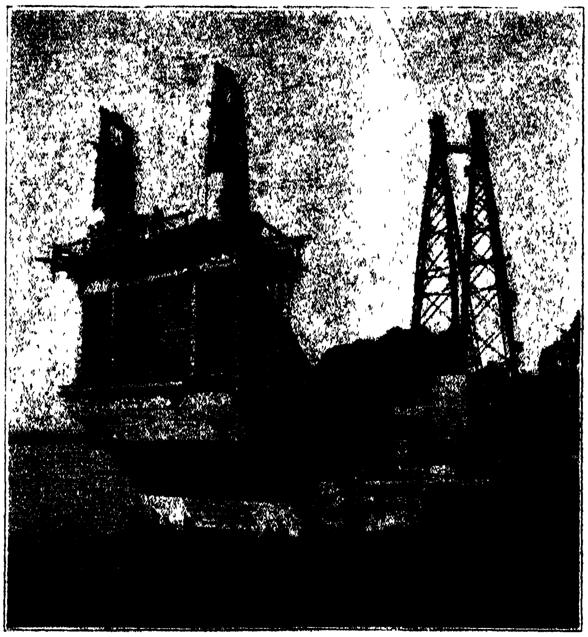
"In the picture the distant mountains are typical of the San Gabriel Range. The long sloping line on the side of the mountain beyond Mount Wilson is a narrow road cut into the cliffs, and was designed primarily to permit the quick arrival of forest fire fighters. Somewhere near the distant horizon at the right, 30 miles away and 8000 feet up, an observer has 'dug in' for the winter. He is studying the 'air' and the 'seeing' at one possible future site for the great 200-inch reflecting telescope."

A New Departure in Bridge Building*

A Bridge of Unusual Design, Built by Unusual Methods, Is Nearing Completion Over the Elorn at Brest, France

By HERBERT E. STEINBERG, M.Inst.C.E.

QUITE a number of English engineers have already made pilgrimages to Brittany, with the object of inspecting the bridge over the Elorn River near Plougastel, which has been under construction for the last three years. Not only is it one of the largest reinforced concrete structures in the world, and designed for both railway and road traffic, but the methods of construction and the extraordinary number of ingenious devices used by the contractors are of absorbing interest.



CELLULAR ABUTMENT

The two small towers on this section contain hydraulic jacks to lift centering. Large towers support cableway

The river at the point selected for the bridge is about 2000 feet wide, with sloping banks on each side, rising fairly steeply to a height of about 120 feet above the water level. The rise and fall of the tide is very considerable, adding to the difficulties of construction.

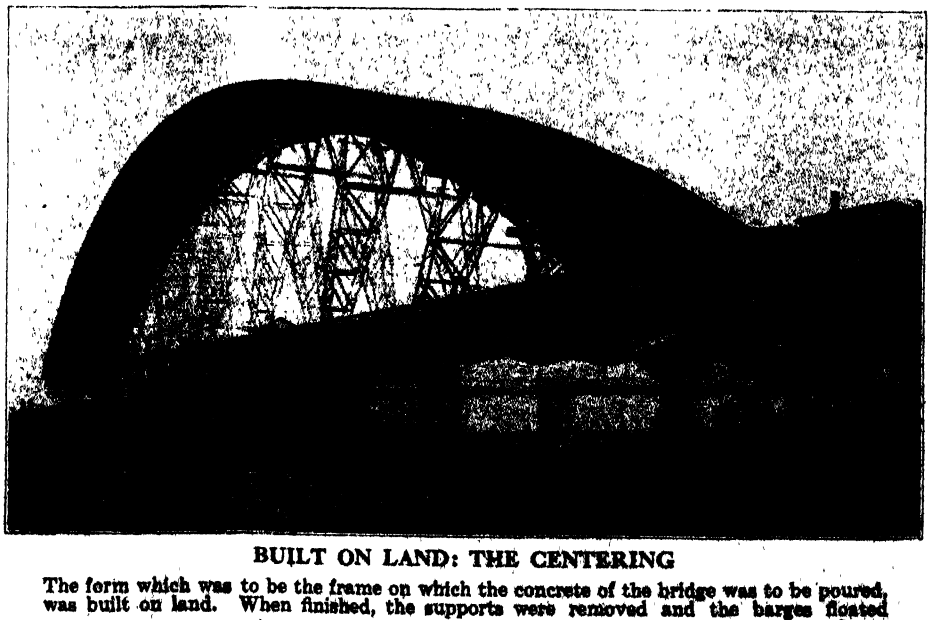
THE bridge was the subject of a competition in design, and the conditions indicated that it had to be capable of carrying a single line of standard railway, as well as a roadway 30 feet wide, for vehicular traffic. A number of designs were submitted, and the three more practical schemes were examined in detail by the commission appointed to adjudicate. Two schemes were in reinforced concrete, and both were cheaper than the third which was a steel scheme. As each of the reinforced schemes was sponsored by responsible engineers, the cheaper of the two was selected for comparison with the steel scheme and, after close investigation, this design was adopted.

It consists of relatively short approach viaducts and three arched spans over the water, each span being 590 feet in the clear. There are consequently two river piers. The arches themselves consist of hollow reinforced concrete vaults having four longitudinal walls and top and bottom slabs. These arches are surmounted by cross walls, supporting longitudinal girders which carry the double deck construction for the railway and road traffic.

Reinforced arched bridges of this type are not unknown, and have already been constructed in spans nearly equal to the bridge now being described, a notable example being the bridge recently opened on the main road between Annecy and Geneva. The methods of construction used for the Plougastel bridge are, however, entirely original as well as being extremely economical and practical.

Several bays of the approach viaducts on each side were constructed in the ordinary manner, with climbing shuttering and timber trusses acting as centering for the reinforced concrete girders. Simultaneously with these viaducts, the river piers were built up to high-water level by means of a reinforced concrete caisson or diving bell weighing about 900 tons, working under compressed air, and surmounted by air-locks, which permitted either concrete to be deposited or spoil to be removed with very little loss of air. The piers were continued above water level, and the springings of the arches were also built, so that they cantilevered out several feet from the center line of the pier. These projecting pieces of the arches were used subsequently to support the centering, and to enable them to do this, their strength as cantilevers was temporarily increased by tying the portions of each side of the pier together with bars having their extremities buried in the concrete. The requisite amount of tension was developed in these bars by jacking them upwards and packing them in the desired position.

IT was decided to use cableways spanning the full width of the river, in order to transport all material. The tenders for the cableway towers and necessary gear were, however, deemed unreasonably high, and M. Freyssinet, the designer of the bridge, therefore decided to design the necessary towers (which are 150 feet high) in timber. The timber, which is all in the form of joists and floor-board scantlings, is



BUILT ON LAND: THE CENTERING

The form which was to be the frame on which the concrete of the bridge was to be poured, was built on land. When finished, the supports were removed and the barges floated

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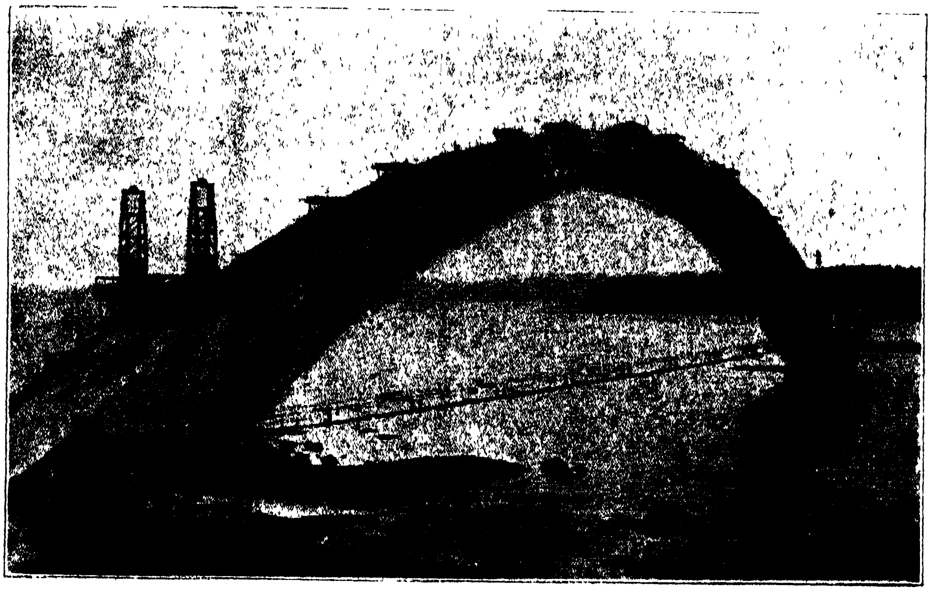
*Reprinted by permission, from *Engineering*, London

connected entirely by nails $^3/_{16}$-inch in diameter and 10 inches long. The ends of the tower have hinged supports formed by burying the timbers in the concrete, through which a hollow mandril has been placed, which forms the axis of the hinge. The towers were constructed horizontally and lifted into position by the cable, which was subsequently to be used for carrying the load. Smaller towers of similar construction were erected at convenient points, as sheer legs, in order to commence the lifting of the main towers. The back stays to the towers consist of a number of ⅜-inch rods connected at top and bottom by means of concrete blocks, and anchored at their lower end to large blocks of concrete buried in the ground.

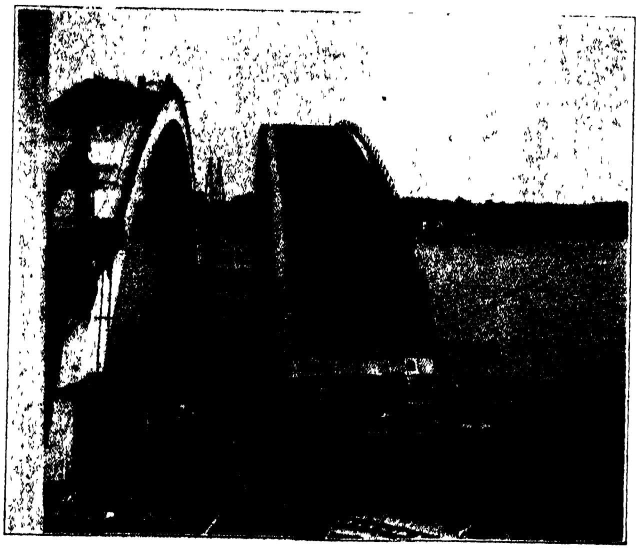


THE FIRST CONCRETE ARCH

The centering was floated into place between the abutments, lifted by means of the jacks in the small towers on the abutments, and fastened; then the concrete arch was poured

THE transporters are worked by electricity, the control cabins containing the motors moving backwards and forwards with the loads. The current reaches the motors through the overhead carrying cables, and returns through small hauling cables. Two similar transporters were built, and have worked without hitch for nearly three years, during which time they have handled many thousand tons of material.

The type and method of construction of the centering for the arches was the chief problem in connection with the bridge. It was finally decided to build a lattice arched centering in timber, which could be used successively for the three spans. To enable this to be done, two pontoons (each weighing 1000 tons) in reinforced concrete, were built, launched, and moved into position on the foreshore. Between them a number of timber towers were constructed, forming the ordinates to the parabolic curve of the centering, the towers near the middle being over 100 feet high. The lower ends of the arched centering, for a length of about 25 feet, were built in reinforced concrete, but the remainder was constructed in a manner similar to the towers for the transporters—that is to say, entirely in small section timber nailed together at the connections.



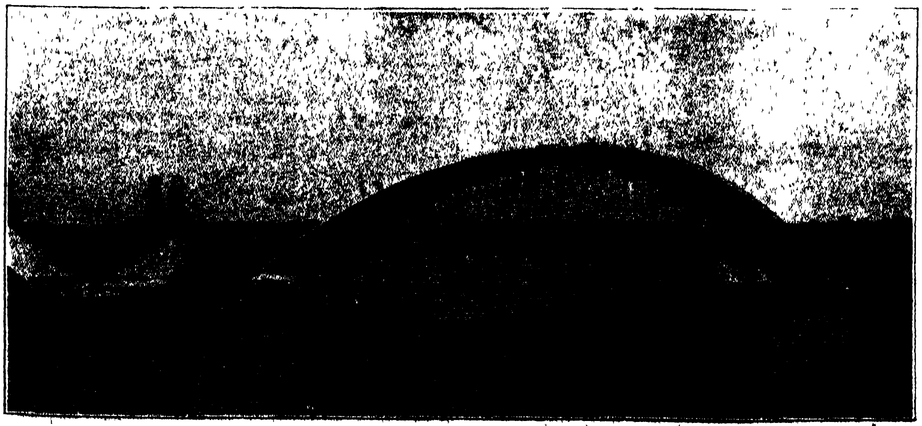
REMOVING THE CENTERING

After the concrete of the first arch was allowed to set, the centering was again lowered to the barges and floated away

Nearly 1000 cubic yards of timber were employed, and about 15 tons of nails. The curved top platform of the centering consists of 9-inch by 3-inch timbers placed on edge side by side, and nailed firmly together. These are surmounted by two layers of planking laid diagonally to act as wind bracing. The lower members consist of a series of ribs each made of four 9-inch by 3-inch joists nailed together and connected to the top boom by diagonal lattice work.

TO make possible the demolition of the temporary supporting towers, the ends of the arched centering were tied together by 80 wire ropes ¾-inch in diameter, and provision was made at each end for tightening or slackening these ropes by means of hydraulic jacks working horizontally. When the construction was finished, the temporary towers were demolished and the water pumped from the pontoons, which, in consequence, floated at the next tide and enabled the entire centering, having a span of nearly 600 feet and a height of 100 feet, to be floated out to its position between the piers of the first arch. This operation took only four hours; and the centering, which weighs 540 tons, was then jacked up and slung to the projecting portions of the arch already referred to. Slings were passed through the cantilevers and through the concrete ends of the centering.

In this condition the centering was, however, not strong enough to take the weight of the concrete, and provision was therefore made for converting it from a bow-string girder to a braced



INTO PLACE FOR THE SECOND ARCH

The centering is here shown, on its two concrete barges, being floated into position for the second arch. The horizontal cables give it additional strength to support the concrete

THE ARCHES COMPLETED

The three arches having been completed, the centering is now useless. It may be seen, under the nearest arch, in process of demolition. In the background is the deck structure

arch. This was done by taking the thrust through concrete blocks direct onto two projecting shelves left on the underside of the portions of the arch first constructed. This enabled the pontoons to be removed, and also permitted the tension cables to be slackened, the centering thus becoming a braced arch and capable of supporting the weight of the wet concrete.

The necessary stone for making the concrete was obtained by quarrying rock close to the site. Good sand was also obtainable locally, and the actual proportioning of the concrete was carefully controlled by test and experiment. A testing machine (in reinforced concrete) for crushing the tubes, was built on the site, and it was found that a small addition of stone dust increased the strength of the concrete. About 26,000 cubic yards of concrete were required.

WHEN the concreting of the arch was finished, the cross cables to the centering were again tightened; the concrete thrust blocks were cut away, and the centering gently lowered by jacks onto the pontoons, which had again been placed in position under each end. The entire structure was then floated out, and into position for the construction of the next arch.

This operation was done three times, but as the final demolition, either on shore or afloat, of such an enormous timber structure presented great difficulties, it was decided to make provision in the last arch for supporting the centering by bolts left projecting on the underside. This enabled the wire cables and the pontoons to be permanently dispensed with, and also permitted the timber centering to be cut, *in situ*, into pieces of convenient length, lowered into the water and floated ashore for demolition.

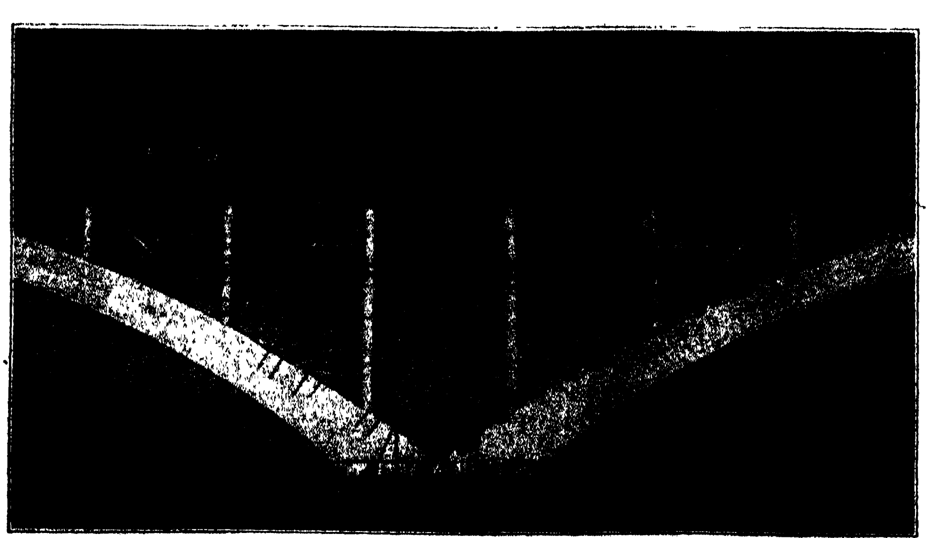
The greatest pains have been taken to eliminate stresses in the permanent work due to shrinkage and elastic settlement. The program for concreting the arch was carefully arranged towards this end, and not only was the concreting commenced and carried forward symmetrically from each side, in alternate lengths and gaps, but the portion of the bottom vault next to the springings was omitted—the thrust being temporarily taken by a series of pre-cast concrete struts. Similarly the portion of the four longitudinal walls next the springings was not done until the remainder of the arch was finished.

In addition to these precautions, niches were provided in the slabs and walls at the crown of each arch (where no reinforcement passed through) and a series of 28 hydraulic jacks, each with a capacity of 250 tons, were installed. These jacks were connected in series and operated by six pumps. They were expanded until the desired opening movement had been obtained, and the gaps were then grouted and the jacks removed ready for a similar operation in the next arch. Incidentally, the walls of the hollow vaults have been thickened slightly at the crown, in order to compensate for the loss of area due to the niches for the jacks.

At the present moment (October, 1929,) the three arches are complete and about two thirds of the timber centering have been removed. The remaining third is still slung from the underside of the arch. The sections of timber centering, after being floated ashore, are dismantled, a simple and practical form of nail-puller having been devised for quickly withdrawing the 10-inch nails.

The timber trusses forming the supports to the longitudinal beams carrying the railroad have been made ashore, and are now being carried out one by one and placed in position between the cross walls, and it is anticipated that another 12 months' work will complete the job. This process is illustrated at the bottom of this page. In the same view is shown the cableway conveyor, described elsewhere in this article, in operation.

THE resulting structure will not only be a permanent example of the genius of M. Freyssinet, the designer of the bridge, but will also serve as an indication of the possibilities of reinforced concrete when both design and construction are in the hands of persons thoroughly conversant with this material. It is impossible in a short description to do justice, or even to mention the many original devices that have been developed and put to use during the construction of the work, but it is hoped that these notes, as the result of a recent visit, may be of interest. The contractors are Limousin and Company. The low anticipated cost of the bridge, coupled with the absence of maintenance charges, together with the artistic appearance of the final structure, should be of service in bringing home the paramount suitability of reinforced concrete for large bridge construction.



THE SUPERSTRUCTURE IS BEGUN

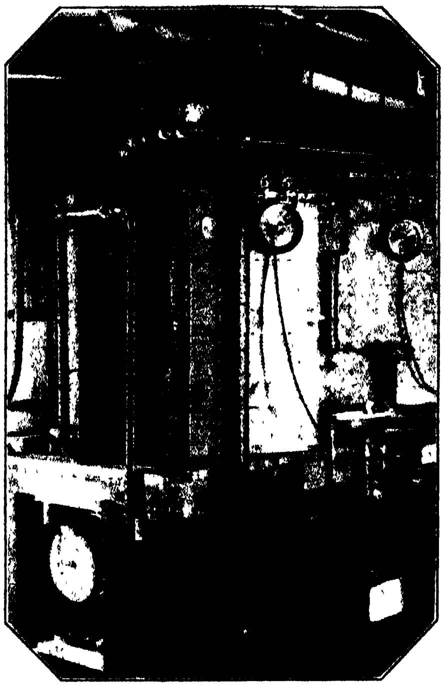
Timber trusses being placed in position for the longitudinal deck beams. Overhead a completed form may be seen being lowered from the conveyor cable. Note thin walls

Movies Take On Color

By A. P. PECK

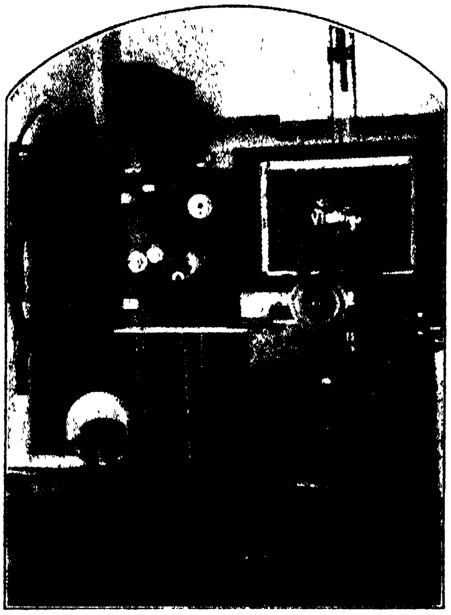
EVER since the invention of motion pictures, natural coloration in the films has been a goal toward which experimenters have worked with but little success until comparatively recently. All sorts of schemes have been tried, ranging from hand tinting of the individual frames to the simultaneous projection of two films, dyed in a separate color range.

The public, however, is critical of its entertainment, and crude efforts at natural color have been greeted with coolness and disfavor. Then the process of film coloration known as Technicolor was introduced, and as it was improved it found favor. Now comes Technicolor's only serious competitor, Photocolor, with a fully equipped plant for processing film and with a fully developed system for producing colored movies that faithfully reproduce on the screen the original subject.



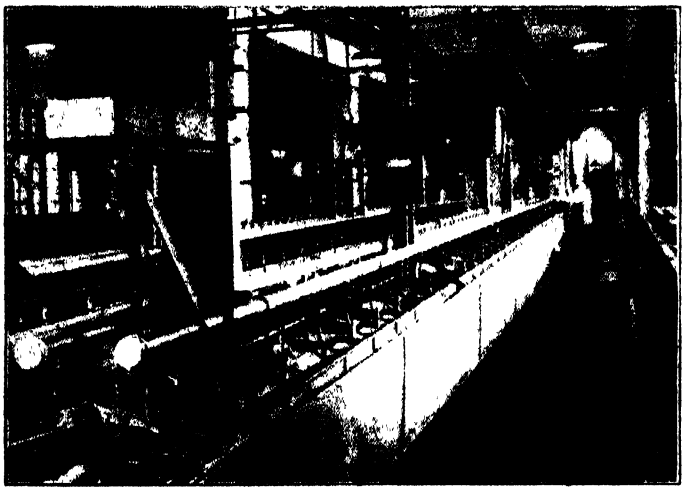
◀ TEMPERATURE CONTROL

Absolute control of the temperature of the solutions is obtained by circulating water



TITLING

In the foreground is the camera; in the background is the stand holding the copy



GREEN-BLUE DYEING

The film, indicated by the arrow, floats on a carefully regulated solution of dye, absorbing the color in the emulsion on one side

All photographs courtesy Photocolor Corporation

RED-YELLOW DYEING

After one emulsion is dyed, as at left, the film is run through the red-yellow bath, where the emulsion on the other side absorbs color

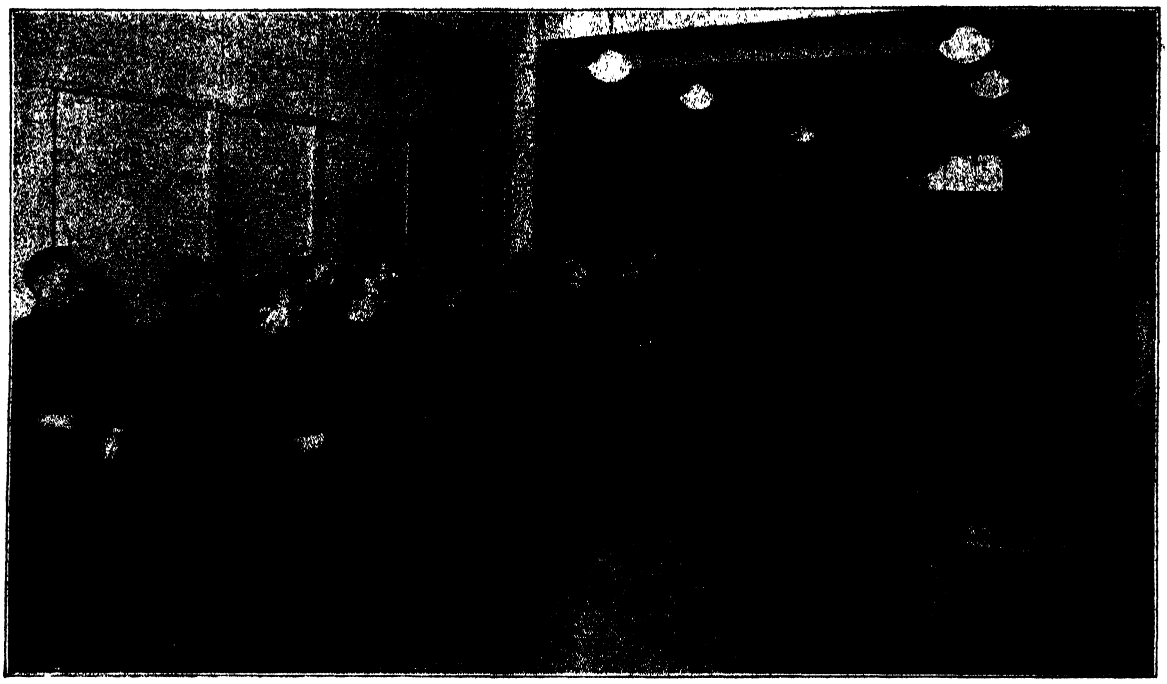
◀ TAKE-UP

After the dyeing operations, the film is dried and wound on these take-up reels

At a recent showing of a Photocolor production, the writer was favorably impressed with the degree of accuracy achieved in reproducing that bugbear of all color photography—flesh tints. Also, unusual in colored movies, pure blacks and clear whites furnished a pleasing contrast to the colors, all reproduced in the proper tones.

The Photocolor process has been under development for several years, during which time it has been refined to a point where a completely equipped plant is ready to start work on feature length productions. Essentially the system is as follows:

The camera is equipped with two lenses and operates the negative film at two and one half times normal speed. This is done because two frames of the film are exposed simultaneously, one through a filter for the red-yellow tones, and the other through a filter for the green-blue tones. There is a space between the frames that is eliminated in the printing. In the printing machine, which is accurate to within one ten-thousandth of an inch, alternate frames are printed on one side of a double-emulsion film, and the remaining negative frames on the other positive emulsion. Thus, the simultaneously exposed frames are registered and combined. When the positive is developed it is still in black and white. One side is dyed with a green-blue dye and the other with a red-yellow dye, the result being a close approximation of natural coloration when projected on a motion-picture screen.



MOTOR TRANSPORT SCHOOL

More than 1800 men in the motor transport school are registered for instruction. The course is very complete and experts furnished by manufacturers lecture. Principles and practice instruction run concurrently

Policemen Are Made, Not Born

In the Highly Organized New York Police College Every Branch of Law Enforcement Is Dealt With in Detail

By ALBERT A. HOPKINS

WHATEVER may be the causes of the organized crime of today—its bold robberies, dastardly disregard for human life, in brief, its apparent contempt for all the laws of society—the situation is critical. Our bulwark against the diabolical minority responsible for this state of affairs is the policeman, who often sacrifices his life so that "they shall not pass." From the humblest patrolman to the chief inspector, the ideas constantly borne in mind are the repressive influences as well as the actual detection of crime and apprehension of criminals. Every police officer is constantly on the alert, as he is part of the eyes and ears of the police department. But the policeman of today does not even remotely resemble the officer of the nineties. The great improvements which the 20th Century brought about are modern means of transport and communication, criminal identification, and police training.

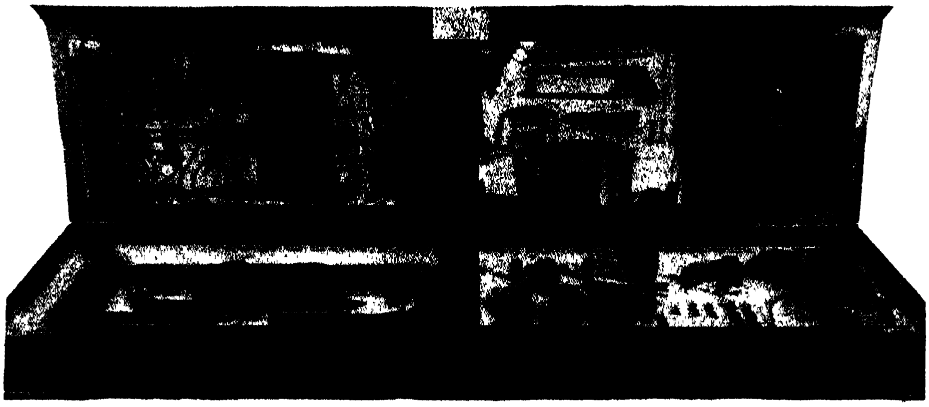
We shall, at this time, concern ourselves with the latter question only. Police schools are not new, for there are 16 of them in the United States. For a long time, however, the Police Academy of New York has had the most elaborate organization of any police school and has recently taken a forward step by the creation of a "Police College" under the Presidency of the Hon. Grover A. Whalen, New York's versatile and efficient Police Commissioner. There are 11 schools in this college, so we could also refer to it as a "Police University."

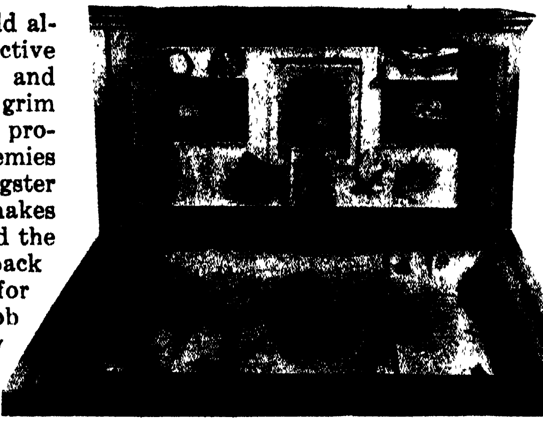
Police work is fascinating, to the lay reader as is evidenced by the great popularity of detective stories which form a large slice of fictional literature.

THE great mistake which most writers make is the creation of a super-detective who co-operates with the police and supplies the brains to Scotland Yard, or any other police headquarters. As a matter of fact, co-operation of this nature would be highly dangerous and has no basis in fact, for on the force are men picked to unravel mysteries and detect crime 365 days a year—the underworld never sleeps and takes no Sundays or holidays off. It is for the training of officers and men of the uniformed force, as well as detectives and "rookies," that the Police College was established.

Crime control must be approached from a scientific viewpoint as well as the practical one. Strong-arm methods are all right in their place, but strong-brain methods are equally important. The police must "outsmart" the criminal or society must suffer. Crime has become so scientific that we must devise improved methods of approach to problems which formerly did not exist. We hear a great deal of Paris, Vienna, Scotland Yard, and other great centers of police investigation, but we have, right in our own land, some of the most successful methods of detection that the world has ever known.

Near Police Headquarters there was an unused candy factory which was admirably adapted for a police school or college. It was rented for a period of five years at an annual rental of 65,000 dollars and was entirely remodeled to house the various schools, record rooms, engineering offices, et cetera. The seating capacity of the schools is 2100. There is an Advisory Board of nine members made up of prominent educators, law-school professors, and one of the assistant district attorneys. When we get down to cases, who is more competent to teach a policeman than a policeman? Superior officers should be the ones to teach the lessons which they themselves have learned by experience which is often bitter and costly. We can cut corners with well planned instruction by those whose personal experiences, both successes and failures, fit them to become teachers of police theory and practice. Therefore 230 men, including a Chief Inspector and sergeants, have been assigned to the teaching force. Special lecturers include Justices of the Supreme Court, Judges of the Court of General Sessions, the United States Attorney, the dean of a law school, handwriting experts, prominent lawyers, surgeons, sanitarians, and criminologists. In fact, 11 pages of the program at the opening contained the names of exactly 500; certainly a large faculty, even though the majority wear blue uniforms and brass buttons.





A "BLACK MUSEUM"

Here are burglar's tools galore, rope ladders, jimmies, and all the evidence in the notorious Snyder-Gray case. The public is not invited to this Crime Museum, now or at any time

SUCH an array of talent would almost make writers of detective stories want to sit at their feet and learn at first hand some of the grim incidents that occur daily in their profession of combatting the arch enemies of society, particularly the gangster and the gunman. The faculty makes policemen out of raw recruits, and the "rookies" will in time come back for post-graduate instruction; for the patrolman's job is a job for young men. After a few years of hard-earned experience, all are able to compete for higher grades in the service and, if possessing ability, may rise to the position of inspector before retirement.

How can the Police College war against the gangster? It is a prime essential that a detective must have an excellent knowledge of the social foe with whom he is likely to deal. To this end, the most experienced men in the department acquaint the new detectives with gangster manners and customs. It would take years to gain the knowledge which these "hard-boiled" detectives impart in three months of intensive training.

THERE is nothing the gunman fears like the headquarters' camera, the lineup, and the fingerprint pad. A cardinal rule of the New York Police Department is that a gangster must be "frisked" on sight, as must his companions, male or female. The average gunman is not a two-fisted animal and without his gun he is lost; and if a gun is found on him the police know where he will be for the next five years. A gun is called a "rod" and a bomb a "pineapple" in New York gang-land. Gangs are constantly under the eyes of the police and are chivied hither and yon with relentless energy, so that sometimes the gangster goes to work from sheer exhaustion and becomes an unwilling member of the society which he has tried to undermine.

All crimes, however, are not committed by gangsters and the detective must be able to piece together the thin web of destiny from almost impossible beginnings: a piece of torn time-table, a half smoked cigarette, or a burned match stick may and has meant the "chair." On one of the floors of the Police College is a "black museum," like the one in Scotland Yard. The "public is not invited" but here will be found policemen and detectives eagerly scanning the exhibits which may mean a gold shield for them, if they answer the knock of opportunity. In one of the cases are over 100 exhibits showing how the "perfect crime" met its Waterloo. It was indeed thrilling to hear the man that pieced together the evidence in the Snyder-Gray case tell how a little scrap of a Pullman ticket led to the identification of Judd Gray, and spoiled a nearly successful alibi. Here are the burned match sticks which also helped to convict him. Here are the two bottles of poisoned whiskey carefully prepared for hubby by the loving Ruth. Here is a magazine with a colored cover and around it are figures showing that if she got the insurance she would have 78 dollars a week for life. Here is the torn Long Island timetable, the sash weight, the chloroform pad, the picture wire, and the necktie, all elements in this revolting crime for which two criminals were electrocuted.

"ROOKIES"

The disarming of criminals is one of the subjects taught and it is not elective either. The "rookies" become splendid athletes and are soon able to cope with brutes of the underworld

HERE are also collections of burglar's tools and jimmies of the 1929 model. It is a travesty on civilization that such ingenuity is spent on the production of such illegitimate tools for an illegitimate purpose when the place of their artificers is in the tool room of an automobile factory earning 15 dollars a day. The wages of sin are not very high; the average burglary nets $29.75—and a chance of a few years in prison.

The detective must have a very wide general knowledge if he is to rise in his profession. One of the principal objects of the college is to train newly appointed detectives to notice significant evidence when they see it. The familiar "*cherchez la femme*" is now changed to "find the bullet and the gun." Today when a criminal fires a shot, he seals his fate if the pistol is found. Fingerprints will identify the finger that pressed the trigger. The juryman hears the fire-

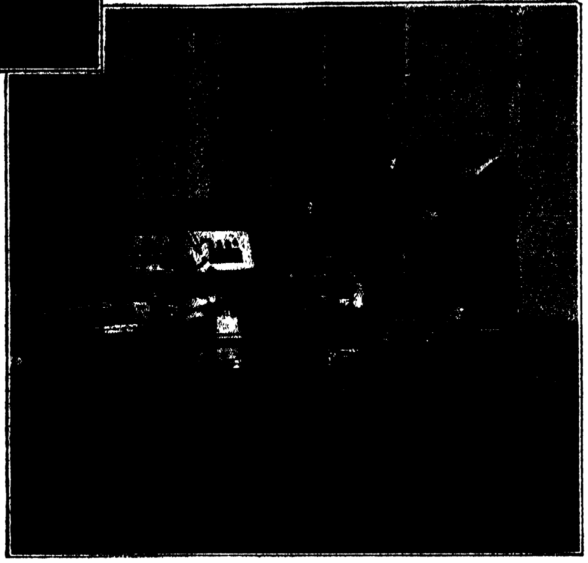
SMALL ARMS EXPERTS

The ballistics laboratory solves many crimes. Here we have Detective Stanley Gorman, small arms expert, and Deputy-Inspector John J. O'Connell, Dean of the Police College, in conference over a mysterious homicide case

arms expert; he gazes into the interior of the barrel; he sees photographic enlargements; he sees and handles the evidence. He learns that no two revolver bores are the same, and begins to realize that the policemen who collect such evidence are being given a scientific training which is very valuable. Ballistics, as taught to student policemen, enables the policeman to solve crimes with a certainty never before attained. By means of it, not only is guilt more clearly proved, but innocence absolutely confirmed. It is accuser and protector in one.

WHILE the College is intended to make "finer and broader minded" policemen, you must first have your policeman. Therefore, a large part of the building is devoted to the "rookie" who is qualifying for the line of blue or "getting on the force" as it is usually called. The candidates may come from all over the country but a year's prior residence in New York, just to get acquainted, is necessary. The applicant must be under 29 and weight not less than 140 pounds. He must pass rigid mental and physical examinations, and is then finger-printed to see if he is a wolf in sheep's clothing. He takes a pledge of office, is given a shield, and is ready for his 90-day intensive training. He is the ward of the city; and he soon sees that being a "cop" is a good deal more than a mere job.

The course in physical training is particularly severe, for the policeman cannot always use kind words. Only the ablest survive, and a close approximation to the perfect type is the goal. The student policeman's day is divided between calisthenics, wrestling, jiu-jitsu, and academic instruction in subjects germane to his future work. Such studies are the fundamental purposes of a police department and the part it plays in society. He studies the penal statutes, the courts, and methods of preparing evidence for the district attorney. The things he learns are too many to specify. He must know that the responsibility is his to stop street brawls, without arrest if possible, restore a lost child, and to aid an injured person before the clang of the ambulance gong is heard. At the end of the qualifying period, if the man has made the grade, he receives his badge of office; is allowed to buy a revolver and to go upon the street armed with authority which he must use with discretion. Present and prospective criminals will shun the company of policemen who are the product of modern training methods.

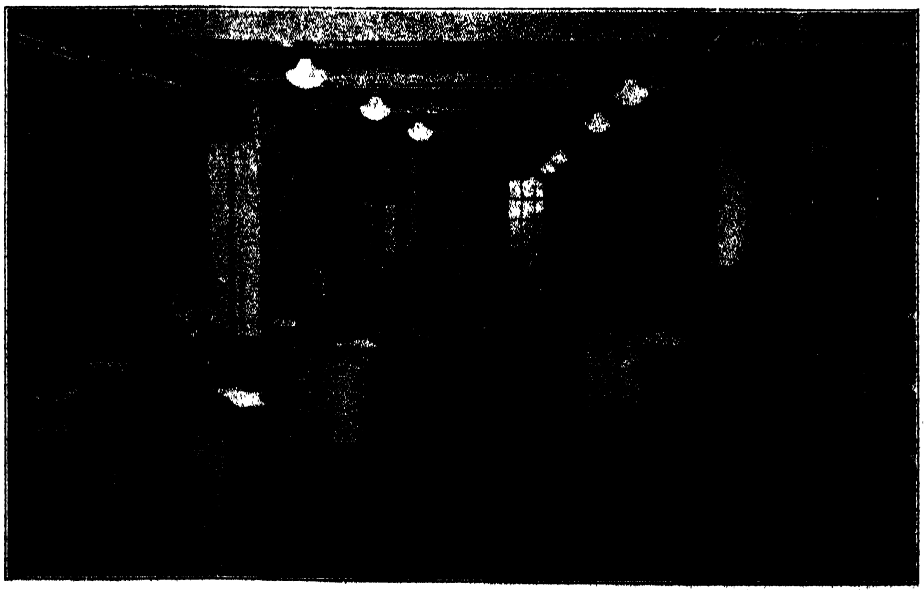


The special schools make the policeman a specialist. The mounted police constitute the "second arm of the service" and the horsemanship school instructs both the man and the horse; the latter must become used to revolver shots. Explosives and small fires are started near him and he is gradually led up close to the fire and shown there is no danger in it for him. While New York City has only 400 mounted men they are a great aid to traffic control.

The motor transport school has 1800 men registered for instruction and many of the large automobile concerns send engineers and instructors to lecture. The traffic school is very important; for New York, of all cities, being "long and narrow" needs the best traffic specialists that can be produced by education, and even policemen far removed from their rookie days must take an intensive course.

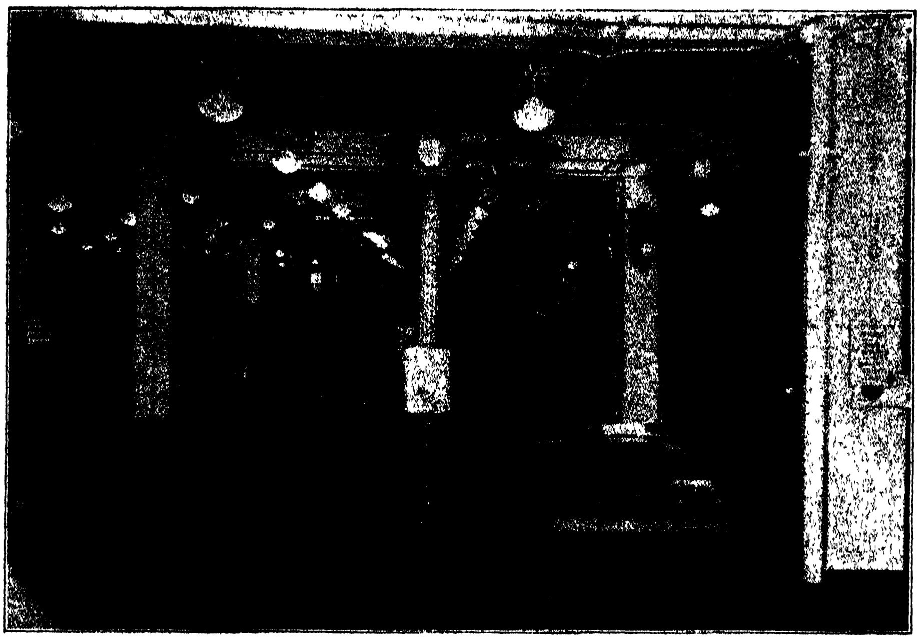
THE motorcycle school gives instructions not only to new men but to the 300 in the motorcycle division. The job is a depressing one, for a motorcycle officer hears enough sad stories to bring a sphinx to tears. All kinds of alibis are offered: one knows the Commissioner, another the traffic judge, still another tenders a "fiver." Despite all these lies, blandishments, and attempted bribery, the officer must do his duty, as he is held rigidly to account.

Grouped under the general head of the Bureau of Crime Prevention are those agencies having to do with all welfare work. The Women's Bureau of the Police Department has a force



THE OFFICE FORCE

They may punch typewriters but they are all policemen, for police work is a man's job, except for the policewomen who have their own field looking after wayward girls, fortune tellers, and so forth. They also receive special instruction in the Police College of more than 125 trained women. Their sole work is to protect women and children and to prevent the latter from passing over the line of safe home life to that of existence as wayward street waifs. Their main activities are the supervision of dance halls, the detection of shoplifters, the curbing of girl adventurers who are looking for the proverbial pot of gold, getting work for girls and helping them increase their earning power, and the detection and arrest of fortune tellers, fake and voodoo doctors, and moving picture "mashers." The Police College has a comprehensive course for police women. Preventive work is especially stressed in this department.



"STOP-GO"

Policemen will be taught all about the traffic and lights on this floor. It looks like the electric show but nothing is for sale. The instruction is class work and demonstrations

THE aviation school was deemed necessary, as modern police work demands that science play its part in the prevention and detection of crime in the air as elsewhere, and that every modern invention be utilized to further the ends of justice.

From more than 1000 candidates among the younger officers, only 12 were selected for this branch of the service. These men receive intensive training, both the Curtiss and Roosevelt fields being used as training bases. The air course in the Police College is thorough and complete. The New York Police Department is the first to have a regular patrolling air force, operating in much the same manner as the policeman patrols the streets.

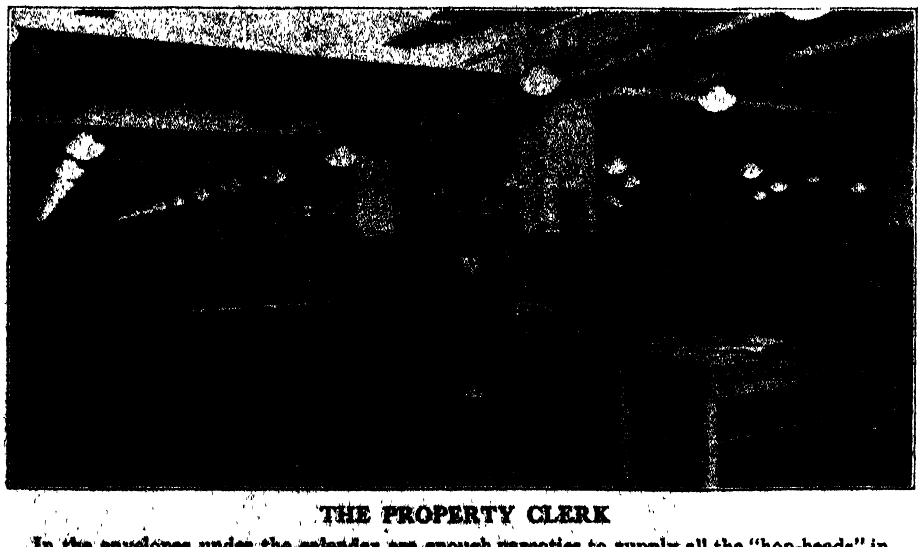
From the policeman, we get the detective. The course of instruction in the School for Detectives aims to give the student ability to apply legal principles to concrete situations; to understand and appreciate people, normal and abnormal; to examine with a high degree of skill every detail connected with a crime; to spare no pains in searching for the slightest clue; to preserve exhibits and to consult experts; to make effective use of traces left by criminals; and to master the technique of criminal investigation in various fields according to their relative importance. This is a big job but the Police College is equipped to turn out an honest-to-goodness detective who could do more in shorter time than Sherlock Holmes. Here is where the well equipped laboratory comes into the picture, involving chemistry, microscopy, and ballistics.

There is also in the Police College a school of law to teach the basic principles of criminal jurisprudence, a training school for teachers, a training school for officers, a specialized training school (police emergency service and clerical instruction), and a school for pistol instruction.

We have covered the College rather hastily but there are also housed in the building certain police activities which are very important. There is a model muster room of a police station house, an exhibition of apparatus for the control of traffic, an auditorium, the property clerk's office, the record room, the traffic engineering department, and the printing bureau. In the printing department, manned by policemen, the confidential circulars, with "Wanted" as a scare head are printed.

If a crook eludes the ring of detectives around New York City, he may ride on the very train which is carrying one or more of his pictures. In less than a week 250,000 police officers will know that he is wanted. The way of the transgressor is hard and is constantly being made harder.

The busy property clerk controls nine warehouses and is the largest second-hand automobile dealer in the world. Here are also many shelves filled with revolvers in brown paper envelopes and enough narcotics to supply every "hop-head" in gang-land for a year. He also has charge of more than 300,000 dollars in jewelry and cash. The record room can trace any of the 20,000,000 arrests made since 1855. Recently they had to look up the history of a woman criminal whose first crime was committed 65 years ago at the age of 15. The elapsed time of the search was less than a quarter of an hour.



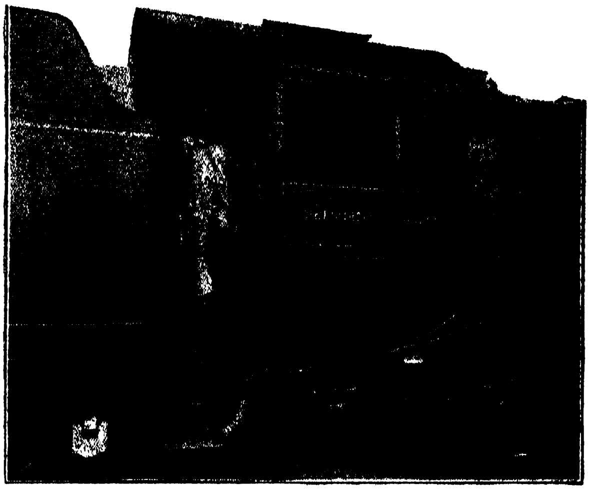
THE PROPERTY CLERK

In the envelopes under the calendar are enough narcotics to supply all the "hop-heads" in gangdom for a long time. Every kind of article comes to the property clerk's office

THE foregoing gives one a feeling that the Police College will do much to aid clear, hard thinking by intelligent police officers so that they may do more to create fear of the law in the minds of criminals than all the jails and punishment cells of the last century. We are indebted to Deputy-Inspector John J. O'Connell, Dean of the Police College, for many courtesies in connection with the preparation of this article.

NO CORNERS HERE

Here the locomotive is sheltered, minor repairs made, and the firing-up process begins. The smoke passes out through a hood to the outer air. The semi-circular form of the round house was born of necessity, as the engine must be routed to tracks



END OF THE RUN

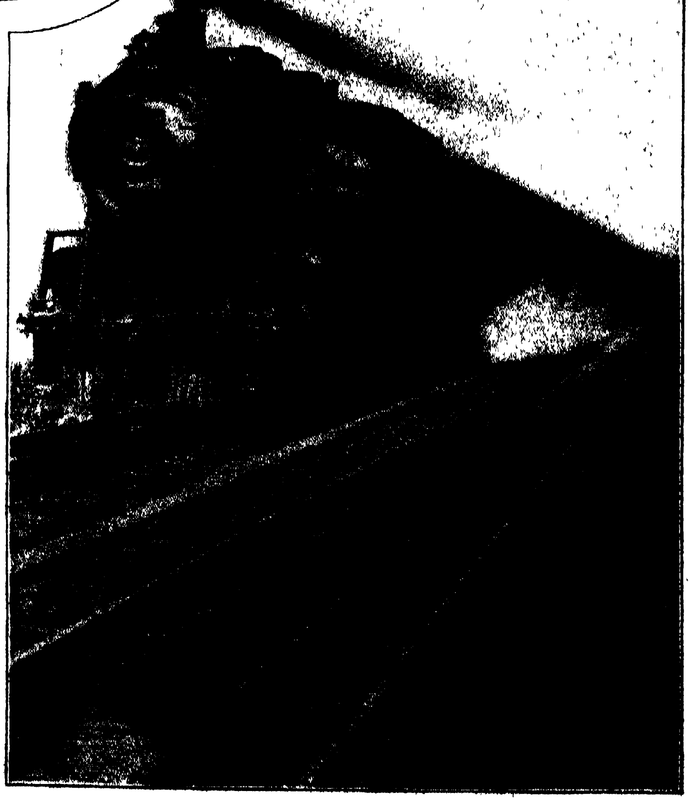
The engineer has brought the giant locomotive to the yard and is about to descend and make out his report. Great care is used to keep the 80,000 dollar machine in order. The locomotive will now be inspected by six experts and the ashes will be dumped

◄ "SAND"

Sand is almost as necessary as coal and water to assist in starting the immense load. The sand is thoroughly dried before it is put in the dome atop the boiler. The sand is blown on to the track as needed

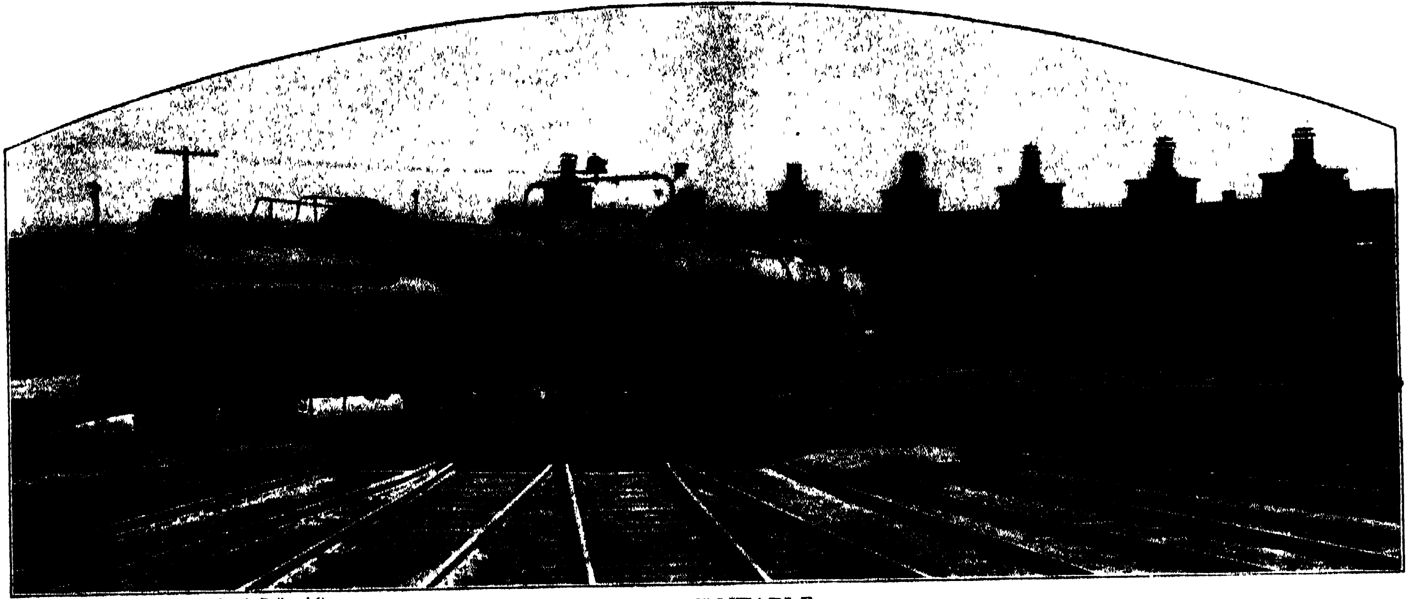
THE READY TRACK ▼

Here the locomotives stand with their crews awaiting the signal to start. They have been cleaned, fueled, watered, and sand put in the dome. They have steam up ready to do their part to help make dividends for the railway company



"WATER" ►

Taking up water en route saves much time. When the track tank is reached, a scoop is let down and the water surges into the water tank on the tender. Track tanks are often a quarter of a mile long and are kept filled



All photos courtesy Baltimore and Ohio Railroad Company

THE TURNTABLE

The electrically operated turntable serves to berth the locomotives in the round house and gives them access to the proper track so that they may be refueled, obtain water and sand, and finally go to terminal or freight yard to be coupled to their burden of cars

'Round a Round House

When Its Hard Day's Work Is Finished, the "Iron Horse" Retires for a Bath and Complete Inspection

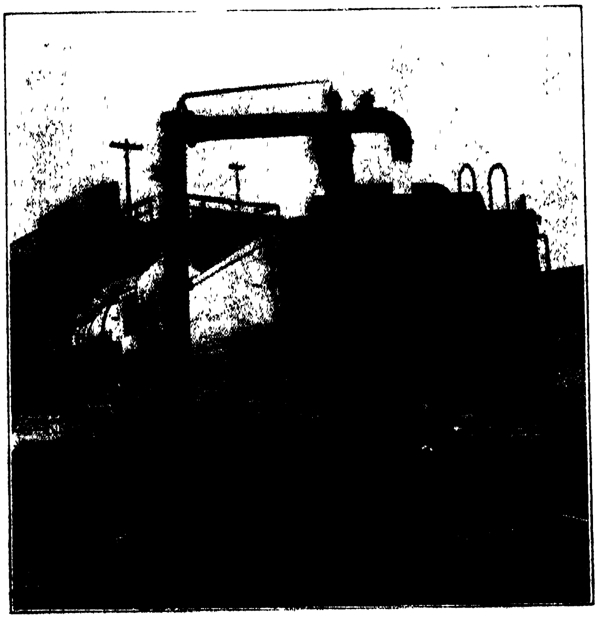
By FRANCIS X. MILHOLLAND
Assistant to the Senior Vice President, Baltimore and Ohio Railroad Company

ALTHOUGH we cannot truthfully say that a locomotive actually sleeps, it is true that a period of rest is beneficial. At the same time it allows a thorough cleaning and inspection of the machine before it again undertakes the responsibilities that accompany its long runs over the rails. Few of the inventions of man see harder service than the engines which haul our passenger trains on schedules that are seldom broken.

While locomotives are built nowadays on a progression system comparable to that of automobile mass production, still there is an individuality about them which is different from that of any other machine. Early in their careers they disclose variability as to steam distribution, acceleration, and tractive effort. All of these little quirks have to be straightened out, so that there may be uniformity in the locomotives as they stand fully fueled, with steam up, on the "ready track."

THE service period of a locomotive begins in its berth in the round house. Probably all have seen round houses, but few have visited them, for rather obvious reasons. A round house should be visited only when "personally conducted" by someone who knows the ins and outs of railroading, for there are many pitfalls in the railroad yards. A round house is a grooming shelter, circular in shape, where locomotives can be berthed for examination and firing up, and where minor repairs can be made. The shape of the building is such that the locomotives may be readily assigned to any designated berth, shifted to it with the aid of a turntable. The same turntable routes the locomotives to the tracks which lead to their daily tasks.

An elongated hood or "smoke jack" is located over each stall of the round house. This, in conjunction with electric motor-driven draft generators, permits the smoke and gases to be eliminated, so as to render the round house less murky than it would be otherwise.



"WATER"

10,000 gallons are poured into the tank. From Washington to New York about 25,000 gallons are used

The locomotives are fired-up with the aid of oil under air pressure. When the steam pressure is high enough to permit operation the engine is run out by the "hostler" on to the turntable, which is rotated so that the engine can be run, either to the ready track, if already supplied with fuel, or to the "coal tipple," where 8 to 12 tons of coal are run by gravity into the coal space of the tender. The coaling is accomplished with the aid of chutes and the amount of coal delivered is charged up against the locomotive and the run. While normally the locomotive backs beside the coal bridge to receive the fuel, means are provided at most terminals for coaling on any one of the mutiple tracks.

The water is supplied to the tank in the tender with the aid of a movable

"REPORTS"

The engineer makes out a report complete in all details at the end of every run

spout. This tank supplies water to the boiler under the direction of the fireman. The tanks hold from 10,000 to 18,000 gallons and a run from New York to Washington would require about 25,000 gallons of water and 11 tons of coal for the engines of the "President" class.

All is now in readiness for the crew, the sand boxes having been filled at time of taking coal. Sand is indispensable and is usually supplied at or adjacent to the coal-handling station. The sand, to be of any use, must be delivered to the sand dome of the locomotive in dry condition so that it will flow freely when needed. Special stove and steam sand driers are available. Varying with weather conditions, approximately two bushels of sand would be required for the trip mentioned. Sand is quite an item. A trunk line may readily pay 50,000 dollars a year for sand. The sand is used for starting, in order to give the driving wheels better adhesion to the rail. The sand is blown on the track with the aid of a compressed air jet controlled by the engineer in the cab.

The crew arrives and the engineer and fireman sign the book in the master mechanic's office. They look over their 80,000 dollar beauty to see if everything is "O.K." The dispatcher's orders must now be obeyed and the engine slowly moves to the head of the assigned train and the coupling is completed. The engineer and the conductor compare their watches. The leaving time approaches. The tower man gets a signal from the dispatcher's office. A lever clicks, a disk or semaphore changes position. The conductor signals the engineer, who sands the tracks, opens the cylinder cocks, and pulls the lever which controls the throttle valve concealed in the dome of the locomotive. The stately machine is in motion over the steel rails and we sit back in our comfortable seats while the begoggled and begloved crew on the pulsating locomotive watch for anything that looks like danger.

In olden days the riding qualities of a locomotive were comparable to those of an artillery caisson. Today, however, this condition has been improved with such spring resiliency and uniformly distributed action of same that the riding comfort of the modern locomotive is almost equivalent to that of a Pullman car.

There is plenty for the crew to do until the end of the run is reached. Then the locomotive backs the empty train out into the yard. Here the engineer stops at the hostlers' quarters, delivers the locomotive to the shop forces, and gives an account of his stewardship in a written report.

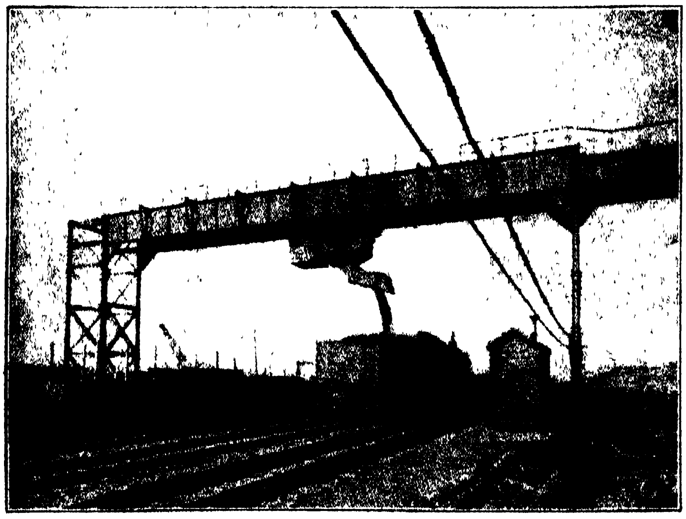
What now becomes of the locomotive? An idle locomotive costs money, but a dirty locomotive is a liability and not an asset. In the early days the engineer and fireman did the cleaning, but as business increased and engines became larger, a group known as "wipers" was engaged to go over the machinery, jackets, and tanks, and finally six or eight men had to spend several hours to "wipe" a large locomotive. Now, however, a new plan has been introduced. This process, using what is known as the "locomotive wash rack," rapidly removes the accumulation of oil, dirt, and dust by means of a mixed stream of air, oil, and water, played at high pressure upon the parts to be cleaned.

When the engine comes in from the run, the ashes are dumped at the cinder pit of the inbound tracks. It is then run on to the "locomotive wash rack." (See photograph below.)

Six men now inspect the locomotive and it is then ready to go to the round house for another preparatory period. At the scheduled or called time, it (we almost said "she," for that is the more affectionate term used by the railroad man), will be tuned up and fired, ready for the next long run.

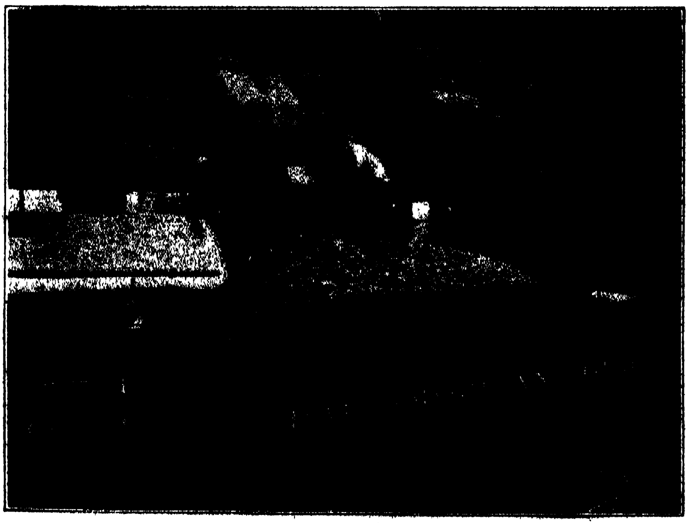
"WASHING"

Hot water, oil, and compressed air clean the engine, replacing a dozen "wipers"



"TRACK FUELING"

Here we have a tender being fueled on an intermediate track. This system tends to save much time in switching locomotives



FUEL BRIDGE

Coal is weighed out and dumped into the coal bin in the tender. The fireman controls the coal consumption by careful firing

Take Your Camera Into the Air

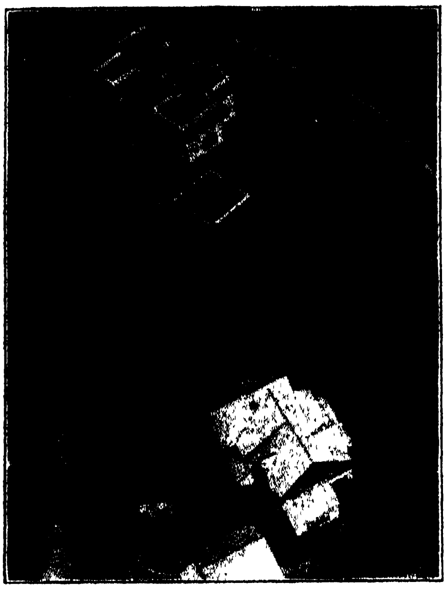
Whether on Your First Flight or on a Long Air Journey, You Can Make Snapshots With an Ordinary Camera

By ROBERT E. GOODE*

AERIAL flights have ceased to be a novelty. With increasing popularity and its attendant publicity, people now take to the air with the assurance of a safe return. With no time being devoted to the working up of an excellent case of nervousness, passengers are finding time to look around while up in a plane.

They are seeing sights from the air. The new angles of familiar objects appeal to them. Perhaps their photograph album at home has a dozen pictures of a show place—good snapshots, too, but none that can equal this "new" view. If on the ground, out would come the trusty camera to record the scene. Why not use the camera while in the air?

Many of us own a camera of some sort. All of us have, at some time or another, taken a snapshot that we secretly thought was just about as good as any professional photograph we had ever seen. That automatically qualifies each and every one of us as an amateur photographer. But in spite of our general knowledge of cameras, most of us are inclined to think of aerial photography as an extremely professional calling. This is not so.



YOUR OWN BACKYARD

As the plane in which you are flying casts its shadow over your home, make a snap

AGAIN, we are likely to believe that special equipment is necessary to obtain beautiful aerial photographs such as are shown in the Sunday rotogravure sections. Neither is this so. The person who takes only a short sightseeing flight should carry his camera along and the person who commutes back and forth in one of the huge airliners should certainly take advantage of his many opportunities to obtain good snapshots.

The old familiar box camera will take pictures from the air as well as on the ground. The Graflex works as well at altitudes as at sea level. It, of course, takes a photograph proportionately better than the family box camera. Familiarity with rapid rectilinear or so-called double lenses of f.8 or U. S. 4 diaphragm opening is a great advantage.

BY AMATEURS' METHODS, BUT GOOD

Mission Beach, San Diego, California, photographed on panchromatic film, using a "minus blue" filter. Note how the filter has made the shoals show up in the water off the beach

Various kinds of ordinary cameras were used by the author in gathering illustrations for this article and a large number of other splendid ones. So you see, any type will operate in the air successfully. Good pictures can be obtained with ordinary roll film and film packs. Clouds and ground haze, however, often complicate the case. A general knowledge of color-sensitive films is helpful. The use of color filters is simple and useful.

A scarcely perceptible haze may ruin an otherwise good picture. Haze possesses a bluish tint that photographs as white. A snapshot taken under these conditions will appear to have been taken through a gauze screen. Fortunately, haze is the only color problem that the amateur need worry about. The resulting cloudy effect can be eliminated by using an orthochromatic or panchromatic film. A yellow color filter should be used in conjunction with these films. Commercial orthochromatic film in either rolls or cut-film form is recommended. Most aerial pictures made by professionals are on this type of film.

PRACTICALLY all of the novice aerial photographers will take their pictures from a large cabin airliner. This is best since a howling wind is not present to interfere with the operations. Moreover, there is more room in which to move about.

It is perfectly feasible, however, to take photographs from an open cockpit type of plane, and in some cases, it may be better. For example, in photographing another plane in the air, the upward and downward angles may give better results. Such shots would be very difficult in a cabin plane. The sketches in Plate I illustrate the angles through which photography is possible in an open cockpit plane.

The folding camera must be protected from the slip stream, otherwise the bellows will blow inward and cut off a portion of the resulting photograph. Moreover, the turbulent air will cause vibrations and resultant blurring. It might even blow the bellows off the camera. The camera may be shielded behind the windshield or behind the body. The pilot is

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*See "Among Our Contributors," page 261

YOU CAN DO AS WELL

This splendid view of a section of Coronado, California, was made with ordinary roll film and no filter was used. With your own camera you can make many such pictures for your album

always willing to throttle down his engine to idling speed if you make your wants known. This will reduce the passing windstream, and will also decrease the vibration of the plane.

By all means always hold the camera with your hands. In this way, the body will absorb most of the natural vibrations of the plane. If you rest your camera on the fuselage of the plane while "shooting," the photograph will be blurred and unsatisfactory. To eliminate blurred pictures further, combine a very short exposure with as small a stop as possible. The exposure should not be longer than 1/100 of a second duration in open cockpit planes.

Plate II shows the positions in which a folding camera should be held for best results. If used as in Figure 2, the viewfinder will show the view in an inverted position as in Plate III.

The box camera, of course, is not adjustable. It is necessary merely to aim it and make your exposure. Remarkable results have been obtained with this type of camera.

THE best altitude for photographs is from 1200 to 3000 feet. If under 1200 feet, the relative motion between the plane and the ground is too apparent and close objects will be blurred. If over 3000 feet, the distance is excessive except for cameras made especially for that purpose.

Operation of the Graflex type is, in general, the same as for a folding camera. In this case, however, the focusing hood will give trouble because of its tendency to blow off. It is advisable to focus your camera while you are on the ground. Mark a scale on the focusing rack to be used while in the air. This will eliminate the necessity of using the hood while in a plane.

Another method of avoiding difficulty with the hood is to re-inforce it with plywood or some light, strong material. Or, you may even replace it with a similar box of plywood or sheet metal. The advantage of these methods is that you can have a perfect focus because the ground glass can be seen at all times.

Focusing is unnecessary when using aerial cameras. Their operation is simple in every way. A direct-view sight is provided in order that sighting can be done from the level of the eye. Some of these cameras require the operator to re-wind the shutters and then to change the film. In others, this operation is combined. No lens stops are provided with aerial cameras but they can be easily made from black paper or from tin, painted black. These pieces are inserted between the elements *of the lens.*

No matter what the type of camera used in the open cockpit plane, take no chances on losing it. Make fast a strong cord on the camera and tie it securely to your body, or to the plane. If it should be blown from your hands, you can at least retrieve it.

The length of exposure is governed by a great number of variables. Among these are altitude, strength of light, conditions of atmosphere, and kinds of filter used.

A "between the lens" type of shutter is used on the ordinary camera. These shutters usually are graduated in 1/100th, 1/50th, and 1/25th of a second—speeds that are adequate for most aerial photography. High shutter speeds are desirable to obtain good results consistently for they help to eliminate blurring caused by vibration and to stop motion at low altitudes.

WHEN vibration and wind can be avoided, as in a cabin plane, 1/25th of a second may be used when at an altitude above 1000 feet. Cameras of the more expensive type have shutter speeds up to 1/1000th of a second. Some foreign types are capable of even shorter exposures.

Eposures may be computed with an exposure meter. In your calculations bear in mind that all views from the air are of distant objects. The most accurate method known is to use a "Justophot Exposure Meter." This is a vision meter which is easily operated by sighting at the object which is to be photographed. The correct exposure is then read directly off a scale.

When photographing through a haze, color filters can be used to advantage. This is also true when a background such as fields appears excessively green or yellow. The use of filters will accentuate detail in these colors.

Light yellow filters do little other than penetrate haze, although they correct slightly for the various densities

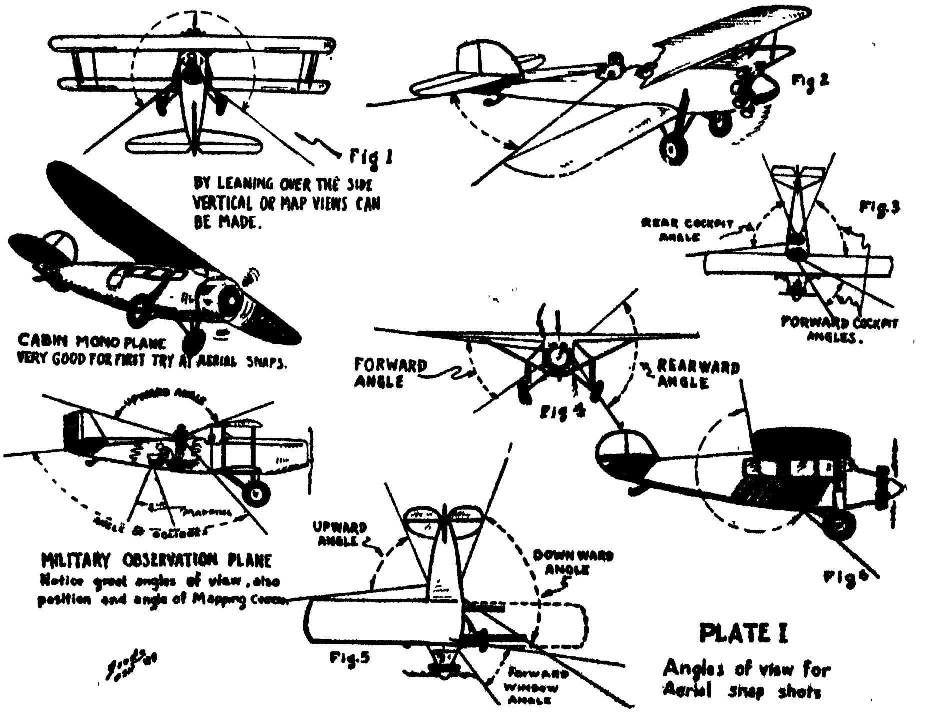


Fig 1
BY LEANING OVER THE SIDE VERTICAL OR MAP VIEWS CAN BE MADE.
Fig 2
Fig.3
REAR COCKPIT ANGLE
FORWARD COCKPIT ANGLES.
CABIN MONO PLANE
VERY GOOD FOR FIRST TRY AT AERIAL SNAPS.
FORWARD ANGLE
REARWARD ANGLE
Fig 4
UPWARD ANGLE
ANGLE OF MAPPING CAMERA
MILITARY OBSERVATION PLANE
Notice great angles of view, also position and angle of Mapping Camera
UPWARD ANGLE
DOWNWARD ANGLE
Fig.5
Forward Window Angle
Fig 6

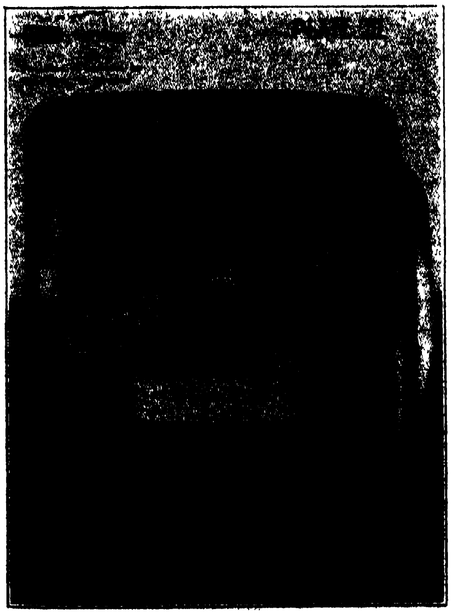
PLATE I

Angles of view for Aerial snap shots

of color. Dark yellow filters fully correct for the apparent density of color. Extremely dark yellow and orange filters are used to emphasize some detail of the landscape. For example, a beach will appear very light while the water will appear quite dark. Often roads are made to stand out clearly from the surrounding country by this manner of over-correcting. Haze can be eliminated by combining these filters with a panchromatic film and a fast lens.

OVER-EMPHASIS is also gained by the use of a red filter. In the resulting photograph, red appears lighter than yellow. Blue shows up as black. Slight variations of green are very noticeable. This property of a red filter was used to advantage during the World War. The green paint and artificial trees of camouflaged objects showed up clearly against the natural foliage. Browns were easily detected when the fresh foliage had dried up. Camouflage fooled the eyes but not the cameras. This partially explains why so much importance was attached to aerial photography during the war. The use of a Wratten K1 filter requires approximately five times longer exposure than when using roll film without a filter.

It is advisable for the beginner to use the gelatin film form of filters for economy's sake. They can be cut to any necessary size to fit between the lenses of the camera. Care must be taken in order to prevent moisture being transferred to the filter by the hands. It is best to cut the filter to size and form before removing the wrapper. This prevents unnecessary handling. Remove the wrapper as the filter is inserted between the lenses. Scratches on your filters should be prevented by handling them carefully by the edge.



LOOKING INTO THE FINDER

Scene will show upside down in finder when camera is held as in Figure 2, Plate II

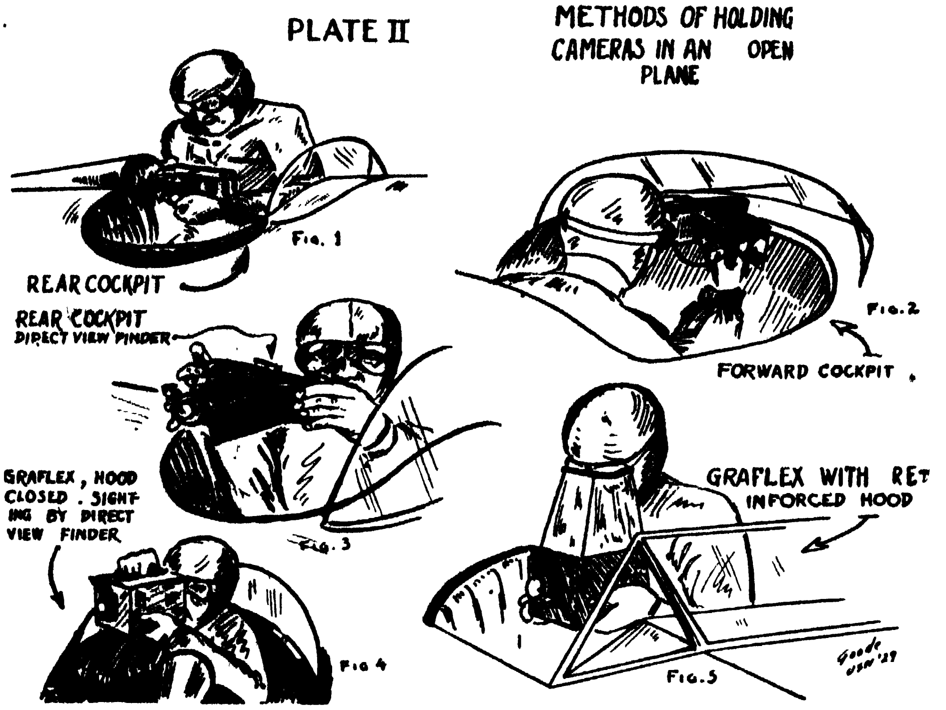


PLATE II
METHODS OF HOLDING CAMERAS IN AN OPEN PLANE
FIG. 1
REAR COCKPIT
FIG. 2
FORWARD COCKPIT
REAR COCKPIT DIRECT VIEW FINDER
GRAFLEX, HOOD CLOSED. SIGHTING BY DIRECT VIEW FINDER
FIG. 3
GRAFLEX WITH REINFORCED HOOD
FIG. 4
FIG. 5

CAMERAS THAT MAY BE USED, AND METHODS OF HOLDING

Orthochromatic film in cut-film form is more sensitive to yellow and green rays than the ordinary roll film. Consequently, when using a filter with this film the increased exposure need not be so great. Generally, the orthochromatic roll film is not so sensitive as the cut film or plate. An exception to this is the Wellington Anti-Screen film. This has a filter manufactured into the film and thus obviates the necessity of any additional filter except under unusually hazy conditions.

PANCHROMATIC films are most sensitive to all colors. They are readily obtainable in either cut-film or plate form. Rolls are provided for the largest aerial cameras. This type of film gives especially clear results if brown predominates the landscape. Because of its sensitiveness to all colors this film is most easily adaptable for over-emphasizing by the use of filters.

Great care must be taken in developing. The red safelights ordinarily used by photo finishers in their developing rooms are as destructive to panchromatic film as daylight. Total darkness is desirable, though a Wratten, series three, green safe-light may be used. If the amateur does not develop his own work, he should patronize a well-recognized commercial studio. Explain carefully just what kind of film you have.

The small motion picture camera which has become so popular is capable of taking excellent pictures from the air. Good results can be obtained with ordinary film and the f.22 stop. Proportionately better results will be had with a panchromatic film and a K1 or K2 Wratten filter. The filter demands a longer exposure, of course. With the K1 filter, use f.16 stop while an f.12.5 stop may be used with the K2.

The motion picture cameras are handled similarly to the still cameras. Avoid vibration and wind blasts. A lens of focal length longer than 2 inches or 50 millimeters will lead to blurring of the resulting picture.

The first attempt at aerial photography may be discouraging. A little practice, however, will give results that are well worth the time and effort spent. More and more people are using aerial transportation. A great many of these passengers carry their cameras tucked away in their luggage. Why not use them en route? Parts of this discussion may seem too complicated to people who have always used their cameras simply to make unstudied pictures—snapshots on the spur of the moment. If you belong to this class, ignore the discussion of filters for the time being, make your snaps according to your usual methods, and you will be pleasantly surprised with the results. As time passes, you will gain by experience and may wish to improve your pictures by the use of filters. In any case remember that:

Working rules for amateur aerial photography may be concisely summed up as follows: 1.—Use as short an exposure as possible; 2.—Exposures in the air are approximately one third of those on the ground; 3.—Hold the camera in your hands and out of the wind to avoid blurring.

¶ *"When you buy your plane" is the subject of a comprehensive discussion coming in May. This article will tell you the things you ought to know if you are in the market for a plane for private flying. Read it and be prepared.*

STRIPPING OPERATIONS AT THE WORLD'S GREATEST OPEN-PIT COAL MINE

Scooping up eight tons of coal, the new electric loader dumps it in the waiting freight cars. The stripper follows, widening the cut and dumping the overburden in the channel behind the loading shovel. In the distance is shown a drag-line excavator with a 150-foot boom

Mining Coal With Mammoth Shovels

Open-Pit Mining Operations at Colstrip, Montana, Using New Operating Equipment of Unsurpassed Size and Efficiency

By HENRY W. HOUGH

ON-THE-SURFACE mining long has been recognized as the ideal method of extracting various minerals from the earth. Two noteworthy examples of such operations are the bench workings of the copper mines at Bingham, Utah, and the famous open-pit iron mines of the Messaba range in northern Minnesota.

Of the numerous coal "stripping" operations, perhaps the most interesting are those conducted by Foley Brothers, Inc., on the Northern Pacific Railway Company properties at Colstrip, Montana. At this mine, new operating equipment of the most advanced type recently has been installed. Colstrip is situated about 80 miles northeast of Billings in eastern Montana—part of the Great Plains.

MAN'S domination of the earth is appreciated when one witnesses the gargantuan work of a new electrically-driven machine, operated by one man, which bites a hole in the ground large enough to serve as the cellar for a house, and deposits the 15 tons of excavated earth a full city block away, perhaps at a height equivalent to that of a 10-story building. Within one minute the operation is completed, and the shovel is back for another 15-ton bite.

This machine, which recently has been placed in operation at Colstrip, is a newly designed Bucyrus-Erie stripping shovel. It weighs 1100 tons, has a 120-foot boom with 90-foot dipper sticks, and a dipper which handles from 10 to 15 cubic yards of material at each load. A special train of 60 cars was required to transport the parts for this equipment from the Bucyrus-Erie factory in Wisconsin to the mine in Montana. This shovel is noteworthy not only for its size and operating speed, but because it has what is probably the longest operating range of any shovel in the world, according to Mr. E. T. Foley, president of the contracting firm which has charge of the Colstrip operations.

THE NEW STRIPPER'S DIPPER

Each time this new shovel bites into the earth, it removes 15 cubic yards of dirt

The stripping machinery was assembled in a new pit which will be two miles long and about 900 feet wide. This pit, which will be slightly longer than that in which operations were begun in 1923, contains more than 11,000,000 tons of coal. The deposit or vein of coal is from 22 to 28 feet in depth, which is several times the thickness of most veins which can be exploited economically.

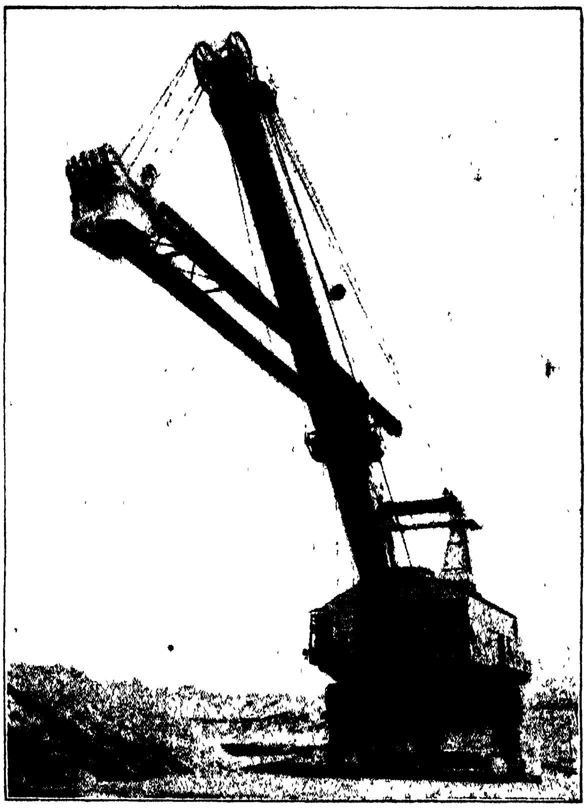
A WORTHY team-mate of the stripping shovel described above is the new Bucyrus-Erie coal loading shovel, another recent installation. This machine lifts out more than eight tons of coal in one operation, raises its load to an unusual height, and dumps the coal directly into gondola cars standing on temporary railway tracks skirting the pit. This operation, as timed by a stop-watch, requires only 45 seconds. In a 10-hour shift this machine will dig and load 5000 tons of coal.

The combined capacity of this loader and a slightly smaller one which has been in use at Colstrip for some time, is 20,000 tons in 24 hours. This much coal would fill 400 average freight cars, or about 300 of the new 70-ton cars recently purchased by the Northern Pacific. The new shovel is probably by far the largest coal loading shovel in the world, according to Mr. Foley. It is operated by an electric motor-generator set, as are all of the other large machines at Colstrip. The Montana Power Company supplies the electricity from its interconnected hydro-electric plants located in various parts of the state.

Other major items of the operating equipment now in use include a Marion drag-line excavator with a 150-foot boom and a six-cubic-yard bucket, a Marion stripping shovel with a rated capacity of eight cubic yards, two General Electric 72-ton storage battery locomotives, and a new General Electric-Ingersoll Rand Diesel-electric locomotive. All of this equipment is used in the pits, with the exception of the drag line, which is used in the initial work of removing the overburden. All of these enormous shovels, including the drag line, move from one scene of operations to another under their own power, crawling on huge caterpillar-type wheels.

BLACK blasting powder is used to loosen the overburden, a layer of sandy earth about 40 feet in depth. This common explosive, probably the oldest known to man, has been used for thousands of miles of railway and highway construction, and is considered "an old stand-by" in the mining industry. Liquid oxygen is becoming popular as an explosive for shooting overburden, but has not been used at Colstrip, to the writer's knowledge. After the layer of earth has been loosened, the drag-line excavator removes the dirt, piling it some distance away in a mountainous dump paralleling the pit or channel. About one and one half cubic yards of overburden are removed for each ton of coal, an uncommonly economical proportion.

Railroad tracks are laid on top of the layer of coal, at one side of the cut. The coal to be removed is loosened blasting, and the loader in the pit scoops it up, raises it to the required height, and dumps the coal in the cars. Following the coal loader comes the stripper, widening the cut. As the overburden is removed, the stripper drops the dirt into the channel behind the loader. The dirt deposited in the cut takes up much more room than the coal did, so as the process continues, the landscape assumes the appearance of a series of miniature mountain chains placed side by side. From an esthetic point of view, the appearance of the landscape is not enhanced by stripping operations, but the workings present an interesting picture, particularly from an airplane.

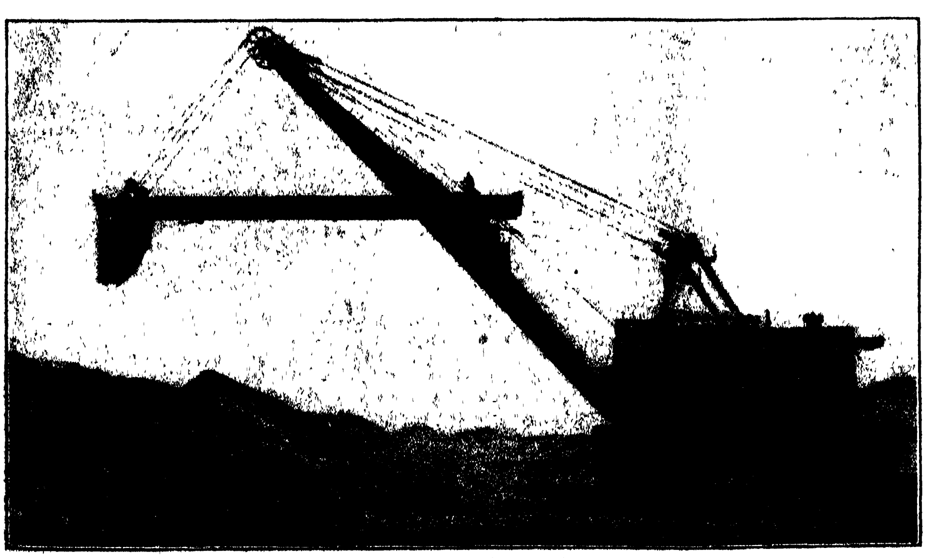


READY TO MOVE A MOUNTAIN

This electric stripping shovel can dump its load at the height of a 10-story building, 300 feet away

Government geologists inform us that the Colstrip operations are being carried on in the Rosebud coal bed of the Tongue River member of the Fort Union formation. The Forsyth coal field, on which the Colstrip property is located, contains approximately 20,000,000,000 tons of coal and extends beneath a region about 800 square miles in area. This field is a section of the great coal bed underlying an enormous region in Montana, Wyoming, and the Dakotas. A strip mine in Wyoming, in another section of this remarkable deposit, is operating in a coal bed 79 feet thick.

THE coal mined in the Forsyth field is sub-bituminous, with heating value about 80 percent of coal produced in the deep mines at Red Lodge, Bearcreek, Bridger, Roundup, Sheridan, Sand Coulee, and other mining centers of the region. Representative analyses show the coal from the Rosebud bed (Colstrip) to contain from 9090 to 13,230 British thermal units. It is shiny black on a freshly exposed surface, but has a marked tendency to slack upon short exposure to weather, a weakness rather common to coals of the region.



THE NEW STRIPPING SHOVEL IN OPERATION

Unusual size, exceptional operating speed, and unsurpassed operating range distinguish this one-man electric shovel. Note the relative size of the man on the dipper handle

Coal always has played an important role in the development of frontier regions. This was particularly true in the northwest. When the surveyors were gathering data required by the Northern Pacific for constructing the first of the northern transcontinental railroads, their reports showed that the new road was to traverse one of the greatest coal bearing regions ever known. Pioneer settlers made it a practice to obtain their winter's supply of coal from the thick beds of the region simply by blasting it off the face of one of the numerous out-crops. The only easier method was to set fire to the out-crop, which was not an uncommon practice. However, such methods had their limitations.

NOT many years after the railroad opened up the country for settlement and development, dozens of coal mining towns had sprung into existence. At first they were kept busy supplying fuel to meet the railroad's needs, but later the industry expanded to meet the industrial and domestic requirements of the rapidly developing region. As the miners dug deeper and deeper and production became increasingly expensive, strange, disquieting

THE COLSTRIP WORKINGS FROM THE AIR

Viewed from an airplane, the workings at Colstrip resemble a series of mountain ridges side by side

rumors began to reach the mining towns. It was said that a new mining property of fabulous character was to be developed by the Nothern Pacific, which had acquired from the government most of the valuable coal lands of the region.

According to these rumors, a great coal vein 25 to 30 feet thick had been located near Forsyth and was to be developed; the coal was so near the surface that it could be dug out by "steam shovels" and loaded directly into freight cars! To most of the miners it sounded like a myth. But industry demands ever-increasing efficiency. It is not enough to equal the production achieved last year by a given number of workers at the same cost. It is required that fewer men working under more favorable conditions shall produce more goods at less cost. Such an inexorable demand can be met in only one way — by creating and utilizing new and improved power-driven machinery to exploit the enormous deposits of low-grade coal. The myth become a reality—daybreak at Colstrip meant twilight at the deep mines.

ROSEBUD County, in which the Colstrip mine is located, now leads the rest of Montana in coal production. Fewer men were employed in the coal mines of the state last year, but the records show increased production and an increased output per man, at a reduced cost per ton.

Two or three men operating the new electrically-driven coal loading shovel described above can dig and load more coal in a shift than can dozens of workers in the average deep mine. Each worker in the pit averages 50 tons of coal a day, or about 10 times the normal unit production of coal mines. Not more than 75 men will be needed at the Colstrip mine to produce the 11,000,000 tons recently contracted for by the Northern Pacific. This amount of coal will be sufficient to meet the company's requirements for this class of fuel for the next eight years, according to present estimates.

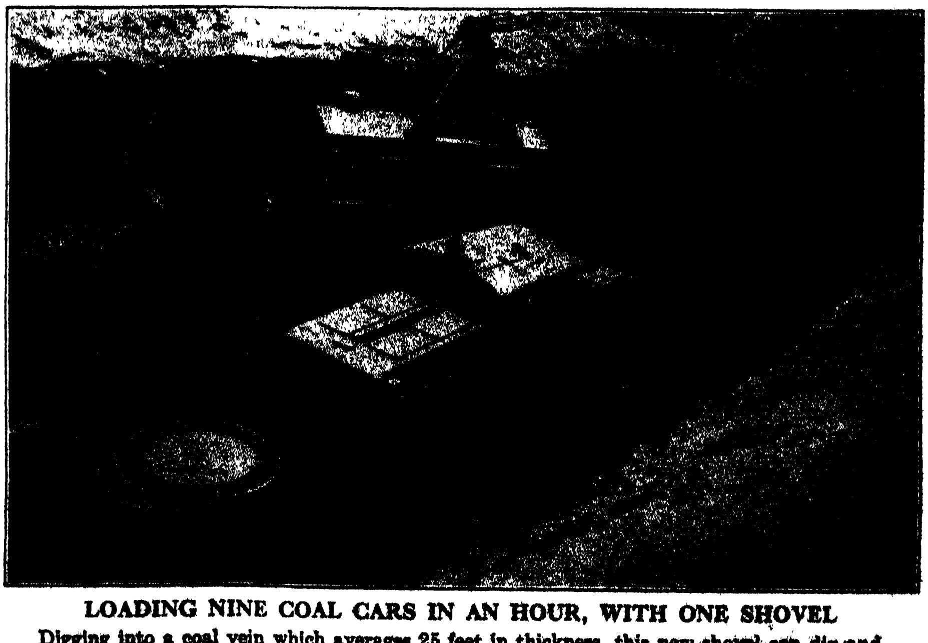
Far-reaching economy has accrued to the railway company through the opening of the Colstrip mine, under its contract with Foley Brothers. Shortly after the government returned the railways to their owners, an economical method was developed for obtaining coal from the Colstrip mine. Then, vigorously commanding its engineering talent, the railway company devised a thoroughly practical method of burning the lower grade coal in its steam locomotives. This proved to be a mechanical problem, involving reconstruction of the locomotive fire boxes.

Today this semi-bituminous coal is being used on all Northern Pacific freight and passenger locomotives operating between Spokane, Washington, and Jamestown, North Dakota. Operating department officials declare that the cheap fuel from the Colstrip mine largely was responsible for decreasing the Northern Pacific's coal bill from 10,233,708 dollars in 1923 to 6,113,721 dollars in 1929.

Revolutionary changes have been made in the type and size of the locomotives, with many resultant economies. Locomotives have been made to haul trains longer distances, and the power of each engine has been increased greatly. In 1922 the company owned 1441 engines with an average power or tractive effort of 38,143 pounds. Between 1922 and 1929 many uncommonly large locomotives were purchased, making it possible to displace and dismantle a large number of the smaller engines. Within this period, the number of locomotives owned by the company was reduced from 1441 to 1099. The average power of each engine was increased to 41,244 pounds.

AS a direct result of using Colstrip coal, the company recently purchased the largest steam locomotive in the world. Its enormous proportions are due to an advanced mechanical design permitting the use of lower grade coal. This locomotive is 125 feet in length, and is of the Mallet type, used in mountainous districts. An order for 11 more of these large Mallets has been placed, and when they are received 28 more engines of ordinary size will be displaced and dismantled. The average power (tractive effort) of the locomotives owned by the Northern Pacific then will be 42,870 pounds.

For many centuries miners have been digging tortuous tunnels deep into the earth in the quest for coal and ore. The development of open pit mining on a large scale is a relatively new phase, but already it has become of great importance in the mining industry. During the average year, the open-pit mines of this country produce approximately 19 million tons of coal, 24 million tons of copper ore, 32 million tons of iron ore, nearly three million tons of pebble phosphate, and about 150,000 tons of bauxite (aluminum ore).



LOADING NINE COAL CARS IN AN HOUR, WITH ONE SHOVEL

Digging into a coal vein which averages 25 feet in thickness, this new shovel can dig and load 5000 tons of coal in a 10-hour shift. Note the electric locomotive hauling the coal cars

Unbreakable Movie Film

Steel-Sheathed Film Reduces Replacement Costs; Has Great Educational Value

FROM the earliest development of motion pictures to the present day, the most costly, annoying, and wasteful defects in projection methods have been the breaking and scratching of film. The cost of renewal prints aggregates millions of dollars each year.

In the rapidly developing use of 16-millimeter or "narrow width" film, which is only six one-thousandths of an inch thick, film breakage is even a greater problem. Millions of dollars have been lost in attempts to develop 16-millimeter projectors with break-proof film for advertising, educational, and "nickel-in-the-slot" motion picture purposes. Projectors for these fields must operate hour after hour and day after day, thus requiring the film to run through the mechanism thousands of times.

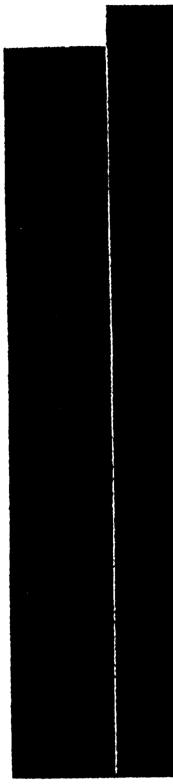
The accompanying photographs illustrate the Dramagraph, a recent invention of Van Dyke Hill, of the Dramagraph Motion Picture Corporation, New York City. The outstanding feature of this projector is the steel-clad, break-proof film used therein, and the method of projecting these strips in a connected sequence to give an unbroken picture on the screen.

The film, cut in 4¾-inch lengths, is sealed between two pieces of thin steel through which an aperture for each frame has been punched and along the edges of which are a number of holes that are equivalent to the sprocket holes in the film. Each film section is equal in length to 16 pictures or approximately 1 second of projection; hence a hundred feet of 16-millimeter film can be loaded into 250 sections.

The sections are stacked horizontally in recesses in the main casting of the projector. Over one recess, or magazine, is an electro-magnet which draws the top section into a breach located at one end of a horizontal track. Claws operating from an intermittently moving shuttle engage the holes along the edge of the frames and progressively move the sections across the bridge to the take-up magazine. Located mid-way of the bridge is the light aperture through which the beam of light emanating from a 100-watt lamp is directed vertically through the film and lens. This beam is deflected along a horizontal axis onto a translucent screen by a superimposed mirror.

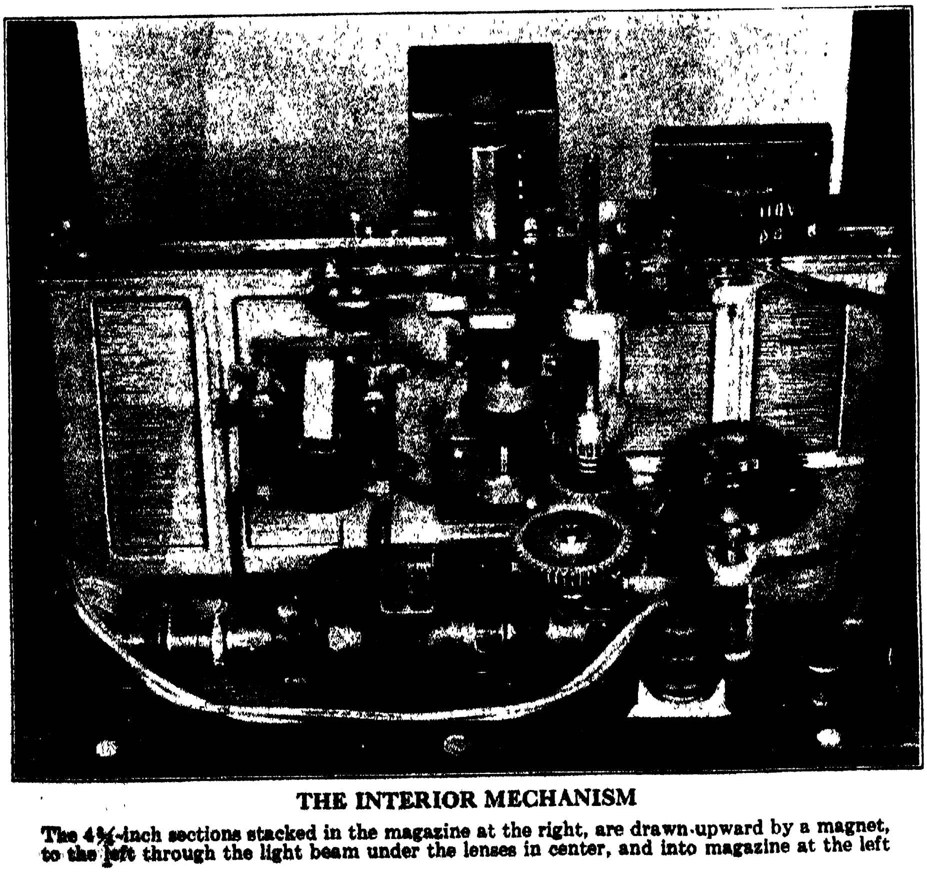
THE PROJECTOR APPARATUS

The light beam is projected upward and is turned through an angle by the mirror



UNBREAKABLE

A sixteen - frame section of 16-millimeter film in its steel protector, compared to an inch rule, at the right



THE INTERIOR MECHANISM

The 4¾-inch sections stacked in the magazine at the right, are drawn upward by a magnet, to the left through the light beam under the lenses in center, and into magazine at the left

AFTER the film sections have passed beyond the aperture, they drop by gravity into the take-up magazine, at the bottom of which is a horizontal conveyor chain equipped with claws which slide the bottom sections off and convey each synchronously to a lifting mechanism at the bottom of the feed magazine. This lifting mechanism elevates each individual frame to a point above a group of spreading pawls which support the stack of frames in the feed magazine.

The frames thus travel upwardly, across the bridge, down through the take-up magazine and return horizontally to the bottom of the feed magazine, the movements being perfectly synchronized. Test runs exceeding 15,000 passages through the system have shown no wear whatever upon the film.

Plans have been made to introduce this type of projector in museums of natural history, libraries, art museums, medical and technical schools, and similar institutions in a form whereby students or visitors can operate motion pictures at will by the mere pressing of a button. The invention will also be used with 35-millimeter film for projecting 10-foot wide motion picture advertising posters in natural colors through translucent screens.

Substituting for Sunlight

Has a New Era of Artificial Lighting Arrived? Illumination That Approximates Sunlight Is Foreshadowed

By M. LUCKIESH

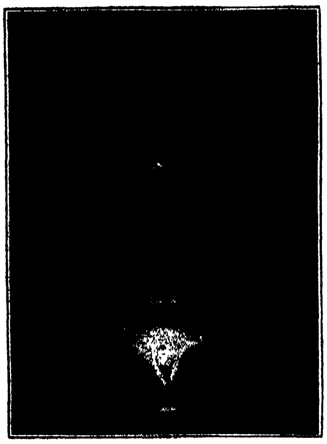
Corresponding Editor, Scientific American. *Director, Lighting Research Laboratory, Incandescent Lamp Dept. of the General Electric Company, Nela Park, Cleveland*

FOR many centuries man has recognized instinctively, or through vague experience, that sunlight is directly or indirectly involved in life processes. During recent years scientific research has firmly established many interesting facts. Ultra-violet radiation was discovered over a century ago, but only during recent years has its influence upon health been established. Much scientific research is needed to fill the many gaps in our knowledge of curative and health-maintaining value of solar radiation. However, we have sufficient scientific knowledge of the beneficial effects of sunlight which, combined with a justifiable recognition of the general importance of sunlight as an ever-present environmental factor, leads us to look forward to the possibility of a new era of lighting with simulated sunlight.

SUCH a point of view, while admitting the desirability of much more scientific knowledge than is available at present, avoids the necessity of making detailed claims for simulated sunlight produced artificially. If an artificial source of radiation emits energy throughout the spectral range of solar radiation (to λ2900) and is found to be an effective substitute for sunlight in those phases of health maintenance and of curative effects which have been established for sunlight, we who light the world are justified in preparing for the opening of a new era of lighting. During the past few years we have been passing through the rudimentary stage of lighting for health as well as vision.

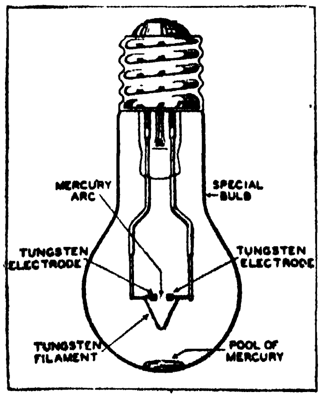
Professional practitioners of radiation therapy, manufacturers of devices which supply ultra-violet radiation, and users of "home treatment" apparatus have not generally recognized the past decade as an evolutionary stage. However, it has been just that. Light for vision is emitted by all the practicable sources of ultra-violet radiation. Up to the present time, the use of the light for vision has been ignored and the effects of ultra-violet radiation have been emphasized, while outdoors throughout the ages man has used sunlight for vision and the health benefits have been ignored or at most have been secondary in his consciousness. With certain beneficial effects established it is logical that we are now ready to consider lighting for health, as a possible adjunct or result of artificial sunlight, incidental in our consciousness as we proceed with our everyday activities.

Anyone who has read, or pursued any other visual task, while exposed to the radiation from one of the many sources available, unconsciously ushered in (for himself) this new era of lighting for health as well as vision. For this act to spread throughout our world of human activities it is necessary that the illuminant contain insufficient radiation of such wavelengths as are harmful to the eyes. Naturally solar radiation, excepting in extreme cases such as reflection from snow, produces beneficial results without the production of conjunctivitis[1] or other known injury. Artificial sources of health maintaining radiation, in order to be used widely for this extended purpose, must meet certain requirements already firmly established in lighting practice. Convenience, safety, simplicity, flexibility are important factors in lighting. The quality or color value of the light must be acceptable.



THE NEW TYPE S-1 LAMP

It is simple and compact, 6¼ inches in length. Its white light, regarded as illumination, is strikingly like natural sunlight



We have available some of the old sources such as carbon arcs, the mercury arc, tungsten filament lamps, and new sources such as the tungsten-mercury Type S-1 lamp and, of course, further new developments. We have sunlight to utilize with special ultra-violet transmitting glass, but artificial light has long ago become an essential to our indoor world. Nearly everyone spends sufficient time under artificial light, and its cost has long ago come within the range of the cost of daylight, so that we may look upon it very generally as an adequate dispenser of the health-maintaining radiation which apparently is chiefly confined to the region between λ2800 and λ3100.[2]

THE sources of light and suitable ultra-violet radiation can readily be screened or so installed in fixtures that the rays that are harmful to the eyes are absorbed by proper transmitting or reflecting media. Already we have a great supply of such data pertaining to the spectral transmission and reflection of common media. But those heretofore interested in lighting must alter their point of view, for materials which conserve light do not necessarily conserve the valuable ultra-violet radiation.

Among the metals, chromium and aluminum reflect quite well throughout the visible and important ultra-violet regions. Oxidized aluminum is particularly efficient throughout this range. Among the white pigments which are approximately equally efficient reflectors of light for vision there is a great diversity in their ability to reflect ultra-violet radiation for health. For example, zinc oxide reflects very little ultra-violet radiation, its absorption being almost complete for radiations shorter than λ3900—the limits of the visible spectrum. Although titanium pigment, lithopone, and tin oxide, efficiently reflect radiation of shorter wavelengths, none of them reflects appreciable energy in the vital region between λ2800 and λ3100. White lead reflects fairly well in this region.

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[1] Conjunctivitis is inflammation of the outer membrane of the eye.—*The Editor.*

[2] The Greek letter λ is a conventional symbol to indicate the wavelength of radiation in Angstrom Units, one Angstrom Unit being a ten billionth of a meter. Radiation of wavelengths in the region between λ2800 and λ3100 Angstrom Units, mentioned by the author, would be in the ultra-violet.—*The Editor.*

The vehicles in which pigments are used in paints and enamels are likewise important. A common mistake is the use of vitrified white enamel reflectors for ultra-violet sources. The "glass" carrier of the pigment absorbs the desired ultra-violet energy. In fact, a black paint is practically as efficient for reflecting this energy as the common porcelain enamels, and graphite is better than several common white pigments.

Transparent glass can be made to transmit as far into the ultra-violet region as desired. Quartz transmits efficiently much farther than desired for the purpose under discussion. Translucent quartz can be produced at reasonable cost to be practicable in fixtures for this new era. Between quartz and common glass there are many possibilities. Apparently, purity of materials commonly used in glass is all that is necessary to extend the transmission to λ2800. However, iron oxide as an impurity is the greatest nuisance. It must be reduced to 0.01 percent if high transmission is to be obtained, even as far as λ2970, which is the region of greatest effectiveness in the cure of rickets and in the production of erythema or reddened skin.

THE production of erythema is important as a step between energy measurements and physiological action. It is also important because it is a visible and sometimes painful result of exposure to ultra-violet radiation. We have found that measurements of energy at λ2968 or λ3024, emitted by the mercury arc, are directly correlative with erythemal effectiveness. In other words, the production of erythema is directly proportional to the quantity of energy in either of these wavelengths. There are indications that this holds approximately for other sources.

Exposure consists of the quantity of energy per unit area and the duration of the application. Exposure to a quartz mercury arc at a distance of 30 inches for a period of five to ten minutes is sufficient to prevent and cure rickets if applied only once or twice a week. Obviously this is entirely too potent to be used in lighting where persons are exposed hours daily, unless the intensity of illumination is greatly reduced. Of course, with such an illuminant goggles would have to be worn in order to protect the eyes. This emphasizes one of the qualifications of an illuminant suitable for this extended lighting purpose. A suitable glass for filtering out too potent radiations can be used with the mercury arc, and such glass is being experimented with. Likewise, any source can be made safe for the eyes.

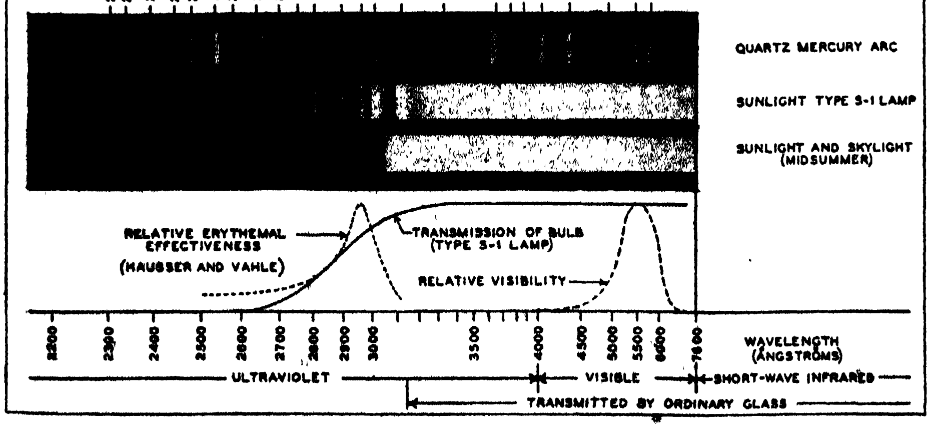
In our study of the tungsten-mercury arc (Type S-1 lamp) we found that the reciprocity law held for erythemal effectiveness over a range of 25 to 400 foot-candles. In other words, an exposure of 10 minutes' duration at 400 foot-candles produced the same degree of erythema as an exposure of 160 minutes at 25 foot-candles.

This brings up the question as to the necessity of producing erythema in order to obtain health benefits. Much evidence points to no such need. In fact, our common experience with sunlight is usually without erythemal result, still we feel that it does us good. Consideration of this question is also connected with that of the minimal quantity necessary to obtain health benefit. Prof. R. Adams Dutcher reported to me several years ago the results obtained with an ordinary 50-watt tungsten-filament lamp on rats which were fed upon a restricted diet. This small lamp was operated in their cage from six to eight hours per day. In three weeks their bone-ash was more than twice that of the control group which was kept in darkness.[3]

This experiment seemed worth repeating, so we made some 500-watt tungsten-filament lamps in special bulbs. Doctor George H. Maughan at Cornell University found that under 20 foot-candles of this illuminant for eight hours per day appreciable improvement was made by chickens which initially had severe rickets. Doctor H. J. Gerstenberger of the Babies' and Childrens' Hospital in Cleveland co-operated with me by using the radiation from this tungsten-filament lamp upon guinea pigs fed upon a restricted diet.[4] For several weeks rickets was warded off.

In this brief account space does not permit going afield or into detail. However, I have given glimpses of dependable data at both ends of the scale—extremely mild and extremely potent ultra-violet radiation. I have obtained sufficient data during recent years with this extended purpose of lighting in mind to feel encouraged to venture into a new era of lighting. I am certain that results can be obtained by means of a properly safeguarded illuminant at the foot-candles required in modern lighting. Many questions still arise. For example, is a substitute for sunlight when used in lighting for health as well as vision a substitute for vitamins? In the case of rickets it has been proved to be an adequate substitute for vitamin D. Whether or not it is a complete substitute need not concern us unduly because people must eat.

IN considering health maintenance along with lighting for vision we are confronted with the same questions as arise in the use of "health equipment" in the home. Much more research has been directed toward the cure of disease than toward the maintenance of health. At first glance it may appear to be impossible to prove whether a group of persons in normal health is aided in maintaining that state of health by exposure to ultra-violet radiation. However, research can establish a good deal along the line of prevention. It has been proved that rickets is prevented by 15 minutes' daily exposure of the body to adequate sunlight. There is some evidence that colds are less prevalent in a group of persons treated with ultra-violet radiation than in a group not treated. Medical men advise sunlight for health maintenance. Certainly interiors should be freed of some of the germs when illuminated by sources emitting ultra-violet radiation between λ2800 and λ3600 which has been proved to be germicidal.



SPECTRAL CHARACTERISTICS OF THE SUNLIGHT TYPE S-1 LAMP

The diagram will repay detailed study for it reveals very many significant facts

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[3] Rickets is a bone-deficiency disease often caused by lack of enough ultra-violet of proper wavelength to cause the bone-forming elements of the diet to be deposited in the bones. In experiments on rats the amount of bone-ash found after the animal has been killed at the end of the experiment bears a relation to the amount of ultra-violet of appropriate wavelength that it has had.—*The Editor.*

[4] In making experiments of this kind on animals it is usual, in order to exclude as far as possible outside factors which might confuse the results determined at the end, to restrict the diet to food elements which do not themselves tend to prevent the occurrence of rickets.—*The Editor.*

All photographs courtesy Buffalo Museum of Science

THE BUFFALO MUSEUM OF SCIENCE

A modern adaptation of classical architecture gives the severe lines appropriate for a science museum. The approach is 100 feet wide. Most of the exhibition halls are illuminated with artificial light only, and many of the animal groups are in miniature form, conserving space

A Friendly Museum

Doing Away With the Disease Called "Museum Fatigue" by Skillful Planning and Lighting

IN the dedication address at the formal opening of The Buffalo Museum of Science, the President, Mr. Chauncey J. Hamlin, aptly described the function of a museum which is often lost to view. He said: "The value of a museum to its community must be measured in terms of service to the citizens of that community. In order to render the largest measure of service possible the museum must be dynamic and not static; it must be not a storage warehouse of dead objects but a hive of spontaneous activity, ever storing up the honey of pleasant memories of having brought a larger share of happiness and joy through opening up fuller and wider horizons of knowledge to a constantly growing circle of friends."

It was with this end in view that the Buffalo Museum of Science was built. The Buffalo Society of Natural Sciences dates from 1858, so there is a real historical background. There are many features of the museum which are unique. It is neither too large or too small. It is not "highbrow," yet it is not at any time unscientific. A pleasure is in store for all who visit Buffalo. The activities of the staff are really remarkable and the organization is a model one. An investment of 2,000,000 dollars has been wisely made. Other cities have science museums either in whole or in part, but this museum has great points of difference which we will endeavor to explain. The museum is located in Humboldt

THE CENTRAL HALL

The artificially lighted exhibition halls open from the great central hall and display the whole circle of the sciences. The exhibits are all so beautifully balanced that the visitor does not tire easily

Park and while the location might have been made more central, the effort expended in getting there will be well repaid.

The building of Indiana limestone appears to be two stories in height set on a high base. Actually it contains a high ground floor story with three floors above it, although the upper floor does not show in the exterior.

The architects were requested to do everything possible to avoid that dread disease known as "museum fatigue." The architects decided that the malady was caused mainly by three things: First, hard floors; second, eye fatigue caused by the necessity of constantly shifting the foci of the eyes from the usual high ceilings in museums down to a nearby exhibit, this often being accentuated by the daylight from the clerestory windows or skylights; third, reflections from the exhibit cases.

To avoid hard floors, rubber and linoleum surfaces were used. To remedy the second cause of fatigue, the ten exhibit rooms were built with rather low ceilings and are softly illuminated by direct artificial lighting. A special exhibit case and plan of lighting were designed to meet the third difficulty.

The usual exhibit case is illuminated by lighting the room brightly and borrowing that light for the exhibit cases. The reason that the lights cannot be placed directly within the cases is because many exhibits are of wax, and they would be destroyed by the heat from the lamps, and it is necessary that all exhibit cases be air- and dust-tight. Fortunately, in the Buffalo Museum, it was decided to use many photographic transparencies to compose an illustrated guidebook to each room. This allowed the exhibit cases to be designed with the electric lights so arranged that they illuminate the transparencies directly but are separated from the exhibit.

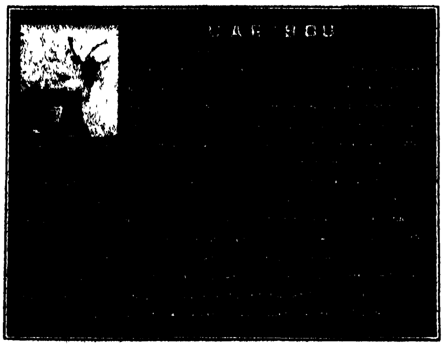
Off the central hall are a series of rooms devoted to physics, astronomy, geology, biology, invertebrates, vertebrates, evolution, heredity and environment, human geography and climate, and primitive races. In the rear is a large hall of plant life. On the second floor are the offices and library; an aquarium room is over the hall of plant life. The third floor contains the laboratories and preparation rooms which are splendidly equipped. On the ground floor is the auditorium, a cafeteria, offices, and a children's museum with a separate entrance.

MAKING ARTIFICIAL FOLIAGE

The extensive laboratories and preparation rooms are on the upper floor

ILLUMINATED LABELS ∨ >

The group shown at the right is in miniature and illuminated labels at the side serve to interpret the group. The labels [below] incorporate text and a picture of the animal itself



THE ASTRONOMY ROOM

The photographs are all illuminated as are all the labels, producing an excellent effect. Such exhibits have great educational value

BUDDING SCIENTISTS

The children have their own museum, their own library, and even their own private entrance to them. They enjoy their privileges

Some Famous Centenarians

There Is No Recipe for Longevity, Which Is Mainly Hereditary.. However, a Milk Diet Seems to Favor Long Life

By JAMES A. TOBEY
Doctor of Public Health

NINE persons who had reached the age of 100 or over died in Ohio in 1928, according to an item in a recent issue of the *Journal of the American Medical Association*. Of these nine centenarians, five of whom were women, one was stated to have been 114, according to her original birth certificate. The average age of the nine was said to have been 103 years and six months.

Many individuals are asserted to have lived more than 100 years, but most of the reputed centenarians are found on rigid investigations not to be centenarians at all. The age of a very old person seems to be one of the matters most susceptible to deviation from the truth, for memories are usually hazy in the extremely old, and the relatives, friends, and neighbors of these patriarchs seem always ready to exaggerate their antiquity. A few years ago a Kentuckian named John Shell received considerable notoriety as being 131 years of age, but a somewhat searching inquiry revealed him to be not more than 100, if he were even that.

IN 1904 a Russian newspaper calmly reported the death at the advanced age of 180 of a woman named Therese Abalva. Another Russian newspaper in 1926 was more modest, for it allotted only 138 years to Ivan Tretya, a peasant of Rostov. A Hungarian farmer, Peter Zortay or Torton, exceeded them all for he was supposed to have been 185 when he died in 1724; as was also St. Mongah, whose death occurred in 1781. Some months ago Henri Barbusse, the French author, recounted his visit in Georgia in Transcaucasia to Nikolai Andreyevitch Shapkovsky, who was reputed to be between 142 and 147.

The cautious reader will regard these allegations with as much skepticism as interest.

One of the most famous of the very aged persons of history was Old Parr, who was said to have been born in England in 1483 and to have died there in 1635. He was working blissfully as a farm laborer at the tender age of 152 when an interested nobleman, the Earl of Arundel, whisked him off to London and put him on exhibition. The fast life of the metropolis proved too much for him and he promptly succumbed. Thereupon, one John Taylor, known as the "Water Poet," got out a book called "The Olde, Olde, Very Olde Man," in which he extolled this long life in prose and verse, or what passed for verse. Thomas Parr was said to have married at 120, and after the suitable interval to have become the father of a child. When he died in 1635, the celebrated William Harvey, discoverer of the circulation of the blood, performed an autopsy on him and found his general condition good, though the brain cells were somewhat worn. A reprint of Taylor's book was issued by James Caulfield of London in 1794.

NOT MORE THAN 100

Old Parr claimed to have been 152 years old, but unkind investigators proved he was mistaken by 50 years, more or less

Old Parr's unusual age was accepted until 1873 when Mr. W. J. Thoms, deputy librarian of the House of Lords, who was so unkind as to make a real investigation of the case, concluded that about 50 years had been improperly tacked on to the actual life of Parr. The gentleman was a real centenarian, but little more than that.

Mr. Thoms also exposed two other notorious long-lifers. A certain Countess of Desmond was credited with 140 years, but the doubting librarian showed that the ages of two separate countesses of the same name had been added together; instead of one person living to 140 years, two ladies had each lived about 70. Thoms examined, in all, 22 cases of alleged longevity and found that none of the records sustained the contentions of centenarianism.

A writer familiar with Mr. Thom's iconoclasm on this subject, a Mr. John B. Bailey, wrote a book in 1888 which he called "Modern Methuselahs," and in it he cited a number of instances of well-known centenarians and nonogenarians.

He began with St. Anthony, who was said to have lived to 105, but most of his other examples, such as the Emperor Cantacuzenus of the 14th Century, Pletho, Cornaro, Titian, de Fontenelle, and Amory, were only 99 or 100. The author, however, did list a dozen cases which he believed to have been actually 100 years old or more. This writer waxed philosophical in his final chapter and, while admitting that these human century plants reached their great ages in spite of a diverse variety of habits, offered a recipe for longevity. His three essentials for "long-lasting" were: good heredity, good digestion, and bodily and mental activity. He quoted these words of Sir Benjamin Brodie, "Men have been known to die, literally speaking, of disease induced by intellectual vacuity."

ONE of the best surveys of centenarians was made in 1899 by T. R. Young, former president of the British Institute of Actuaries. At that time he could find only 22 indisputable instances of such aged persons, but in a second edition published in 1905, he added eight more. The longest authentic life he could discover was one of nearly 111 years. Mr. Young discusses all of the previous works on longevity, of which there had been a considerable number, such as the works of Flourens in 1855, of Pinney in 1856, and of Humphry in 1889, as well as that of Bailey alluded to above. Contrast the conservatism of Young with the exuberance of one James Easton, who in 1799 got out a book listing 1712 persons who had lived 100 years or more between 66 A.D. and 1799 A.D. Old Parr and the Countess of Desmond were both on his list.

In a rather weighty tome on the prolongation of life, Professor Eli Metchnikoff, the famous bacteriologist, hazarded the opinion some 20 years ago that human life ought to average at least 120 years. In his book he describes various persons who were supposed to have attained great ages. Among them were Marie Priou, who died in 1888 at the alleged age of 158, after subsisting for most of her life on cheese and goat's milk; and there was also Nicole Marco, who lived to be 110 on a diet of bread and milk.

The Metchnikoff formula for long life was to drink soured milk containing the Bulgarian bacillus, though he also recognized the value of hygiene and sanitation. Today it is known that it is not the B. Bulgaricus, but the acidophilus bacillus, in soured milk which exerts a favorable influence on the digestive tract and hence contributes to longevity. Metchnikoff's theories were based on observations on the vigor and longevity of various Balkan peoples who lived on such fare. It is claimed that Bulgaria has more than 3000 centenarians even today, while other Balkan countries such as Rumania and Turkey are likewise so favored.

A WOMAN, Maria Ustav, who died in Carcalia in Rumania in 1927, was asserted to have been 135, while Milo Frantsitch of Yugoslavia, who also died in 1927, was reputed to be 126. Zaro Ago of Constantinople was living there in 1928 at the alleged age of 145. These people are undeniably old; you can believe the actual ages given for them or not, as you think best. Personally, I have my doubts.

The alacrity with which newspaper writers seize upon convenient facts regarding supposed centenarians and exploit them in the press is well illustrated by the news story about old Nah-Nee-Num-Skuk, which appeared in the papers a year or so ago. This ancient red man was definitely asserted to have been born in 1809 and thus to have been 118 years old in 1928, but not one scintilla of real evidence of his age was offered, unless the fact that he had had six wives could be so considered. More than a mere statement of extreme old age is needed to be convincing. There is, unfortunately, no way to diagnose exact age from appearances or physical condition. Authentic birth records offer about the only reliable proof.

In the Massachusetts town of Shutesbury is a monument to one Ephraim Pratt, who is stated to have died there in 1804 in his 117th year. According to the inscription, "He swung a scythe 101 consecutive years and mounted a horse without assistance at the age of 110." An investigation of this case by Mr. Leon F. Whitney revealed that old Ephraim had indeed been a centenarian, but that he did not live more than 100 years. Mr. Pratt's longevity was attributed to his diet, which was said to have consisted chiefly of bread and milk.

The question arises as to whether diet may not actually have an effect on the length of human life. That it may do so is indicated rather definitely by some extensive experiments conducted in the laboratory of Professor Henry C. Sherman at Columbia University in New York. For more than ten years extensive nutritional investigations have been carried out there on white rats. In a study of 400 of these animals, it was found that by doubling the amount of powdered milk in the diet, a gain of exactly 10 percent resulted in the span of life for both the males and females.

In human experience (for studies on laboratory animals may properly be compared to it) this would indicate that at least six years could be added to human life by means of proper and optimal nutrition. Pure milk, the most nearly perfect of the foods of man, was successful in lengthening life in this instance, and it is interesting to note that most of the famous true centenarians are reported to have subsisted largely on diets in which dairy products have been prominent.

NAH-NEE-NUM-SKUK, 120?

Born in 1809—according to the newspapers—this old Pottawatomie still was living at a Kansas reservation in 1928

Nutrition is, of course, only one of many factors which may influence longevity. The most important element in the ability to live long unquestionably is heredity. If all or most of our immediate ancestors attained to ripe old ages, generally well past the proverbial three score years and ten, it is likely that we shall also do so, provided we can escape the ravages of disease, avoid accidental death, and refrain from being hung for our sins.

Given two persons who, like Professor Sherman's rats, had exactly the same heredity and the same environmental conditions throughout life, the one who partook of an optimum diet during his entire existence would probably live longer than the one who had only an adequate diet. Such severe conditions are, however, practically never encountered, though there are instances of identical twins who have been separated in infancy and brought up under different environmental conditions, with the result that one has displayed an adult physique superior to that of his twin brother.

Most of the recipes for longevity are no more scientific than that given in a book printed in 1722 which revealed the secret of "rejuvenescency" of one Arnoldus de Villa. It consisted mainly of eating stewed vipers. Similarly, many of the warnings against practices which are stated to be sure to shorten life have little if any scientific foundation. Some of the current food faddists, for example, are vigorous in condemning white bread and attributing all of the ills of mankind to its use. The scientist realizes, however, that a diet with bread and milk as the basis comes as near to fulfilling average physiological needs as can any combination of known foods.

THE real centenarians are reported to have subsisted on all kinds of fare and have indulged in all sorts of hygienic practices. Some of them have eaten white bread, and some brown; some have smoked continuously and violently, and some never; some have partaken of the cup that cheers, and some have been total abstainers; some have trodden the primrose path, and some have been celibates; some have been cheerful, and some morose. Every centenarian usually attributes his longevity to his own peculiar mode of life, regardless of its correlation or lack of it with the accepted rules of hygiene.

The fact that some centenarians have reached great ages without special regard to hygiene is not, of course, an argument in favor of such a regimen. Luck may have been with them, and fate may have played its mysterious part. The average span of life has increased greatly in the last half century, though practically all of the increment has been in the ages below 50, particularly in the periods of early life. This increase has been due to many conditions, of which improved sanitation, better nutrition, more favorable economic circumstances, and biological influences are among the leading factors.

Although a regimen of life might be outlined for an individual case which ought theoretically to assist in prolonging that particular life, positive assurance could not be given of its success, because there are so many complicating factors. There is, in fact, no definite recipe for longevity, and the fountain of youth is still unknown, though science is nearer to the explanation than it ever has been and it may conceivably uncover the secret sooner or later. The average duration of life will unquestionably continue to increase and the mortality rate to decrease, until the biological limit has been reached. When that will be, no conservative scientist can foretell.

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Sinking a "Mine" Under New York City

FAR below the streets of New York City, working day and night while the city's millions toil, seek pleasure, and sleep overhead, an army of workmen are now engaged in the gigantic enterprise of constructing a new tunnel through which will flow the additional millions of gallons of water daily needed to quench the thirst of the metropolis. Sixteen electric mine hoists and 62 mine locomotives are used in this project, for the work follows the same general lines as that necessary in mining.

A tunnel of the New York City water supply system. The tunnel being built will be even larger

The new tunnel, officially known as City Tunnel C Number 2, is being constructed by Patrick McGovern, Inc., for the Board of Water Supply. The mine hoists and locomotives which, with other electric equipment, were built by the General Electric Company, form the major part of the electric motor-driven machinery.

New York City now uses 875 million gallons of water per day, 30 percent of which comes from the Croton reservoir system, and 70 percent of which is supplied by Catskill water. The present distribution system has long been recognized as inadequate for future needs, and even at the present time is not large enough to maintain suitable pressure in the Boroughs of Brooklyn and Queens.

The new tunnel will run from the Hill View Reservoir, east through the Bronx, then south under the East River through Queens to Brooklyn, ending at Hamilton Avenue opposite Governor's Island. It will be 20.2 miles long, will be 17 feet in diameter when finished and will be at a depth of about 500 feet below sea level. Its construction will involve the sinking of 16 shafts from 14 to 32 feet in diameter, the depths of the different shafts varying from 500 to 850 feet, according to the land elevation. After the tunnel is completed, these shafts—with the exception of that at Hill View, to be used as an intake—will be used as risers to valve chambers from which the street mains will be supplied. The tunnel and shafts aggregating 22 miles linear measurement will be excavated to 19 feet diameter which will involve the blasting and removal of almost four million cubic yards of hard rock. Lining the tunnel to 17 feet diameter and incidental construction work will require the placing of 664,000 cubic yards of concrete. This work, together with other minor items, is to be completed in 70 months.

Electricity plays a vital part in the undertaking. Air for drills and shovels is furnished by 400-horsepower synchronous motor-driven compressors. As the muck is removed it is hauled through the tunnels to the hoists by storage-battery mine locomotives.

The mine hoists in the main shafts are each equipped with two cages in balance, one coming up as the other goes down. These cages are rectangular in shape, while the shaft is cylindrical, the space remaining being used for water pipes, air pipes, electric cables, et cetera.

Sixty-two seven-ton storage-battery mine locomotives will be used for haulage in the tunnel. These machines correspond in type to those used in the construction of the Cascade, Moffet, Hetch-Hetchy, Shandakin, and Cold Brook-Wachusett tunnels. Each locomotive is driven by two 12-horsepower motors, power for which is furnished by a storage battery consisting of 42 Exide cells. When the storage batteries are discharged, the locomotives are hoisted to the surface for recharging the batteries.

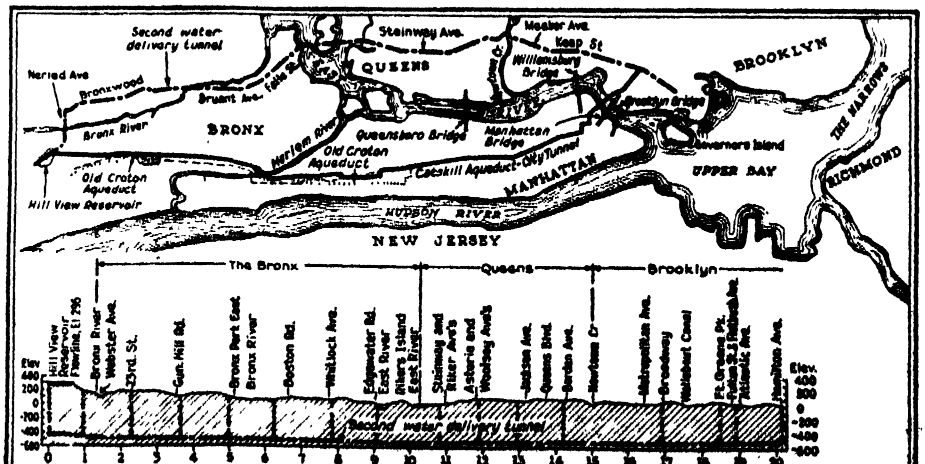
"Spider Threads" of Glass

SPIDER threads of spun glass, which rival in fineness those produced by the living insect, may easily be made by man and are of use for telescope cross wires in the instruments of the engineer, where they prove superior to the natural article. Natural spider thread will swell and lengthen as it absorbs moisture and, in damp weather, telescope cross wires of this material will buckle and sag, at least causing annoyance, or perhaps rendering the instrument useless for the time being. The replacement of these wires is at all times a delicate job and is particularly difficult in the field.

Glass fibers are not affected by dampness or by ordinary variations in temperature, are smooth, straight, and stiff, and do not need to be placed under tension in mounting. They may be drawn as fine as spider web without particular difficulty, with a very simple apparatus and a moderate amount of skill. They are remarkably strong and will stand a great deal of abuse. Being round and having a polished surface, they act as cylindrical reflectors; and light impinging upon them in the telescope is reflected away from the observer's eye, causing the wires to appear as dense black lines out to the edge, whereas spider thread, on the contrary, becomes translucent. It is, in consequence, easier to point the telescope so equipped upon the objective under adverse conditions of visibility.

Fibers used in telescopes of ordinary magnifying power, such as 30 diameters, will be from one to four ten-thousandths of an inch in diameter, depending upon the use of the instrument. Fibers as small as these can hardly be seen with the naked eye. They can easily be felt, however, and such a fiber of glass can be wound about the finger like common thread.

A convenient form of apparatus for drawing these fine fibers, and one which is easy to construct, is a catapult such as is shown in the diagram. This may be made of wood with an arm of some springy material such as hickory or ash. The end of the arm should have a hand-like cup for holding a small segment of glass rod. In operation this arm is held back by a trigger and a small section of glass rod, approximately one inch in length, is placed in it, one end of the rod having been drawn out to a small tip. A similar piece of rod which has also been drawn to a small tip and which has a small round bead of glass at the end of the tip, is clamped to the base of the catapult and the two pieces of glass

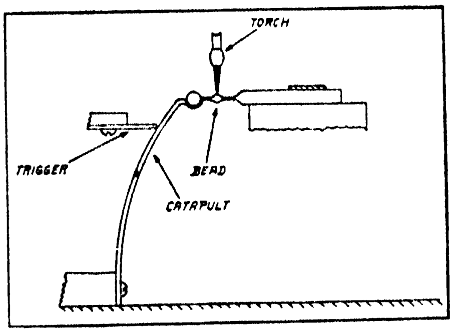


Plan and sectional diagram of the new water tunnel, showing, in the plan, the layout of the old tunnel. Note depth under familiar sections of the city are then joined with a small blow-torch. As soon as this welding has been completed and the glass is cooled, a fine needlepoint of flame is directed upon the bead and as soon as this is a bright red color, the flame is withdrawn and the catapult sprung with the trigger. This act, because of the small quantity of glass involved, must be performed almost instantly and the withdrawal of the flame must slightly precede the springing of the trigger.

The small piece of rod in the catapult arm will be thrown a distance of several feet, drawing out the heated bead of glass behind it into a fine thread, the fineness of which will depend upon the size of the bead, the degree to which it has been heated, and the strength of the catapult arm. It is preferable to have the glass thrown over a dark cloth to assist in seeing the fiber, as it is almost invisible. With a little practice, very fine fibers may be made with this simple apparatus.

Bones Grown in Test Tubes

A MOST amazing case of living tissue being grown outside the animal body is the growth of embryo gristle or cartilage into bone. This remarkable transformation has been accomplished by Miss Honor B. Fell, working at the Strangeways Research Laboratory, Cambridge, England.



"Spider threads of glass" can be made with this simple apparatus

When the proper conditions of nourishment and temperature are maintained, isolated cells from animal embryos have been seen to grow and develop in the test tube just as if they were still in the animal body. Miss Fell, using a technique similar to one devised by the late Mr. Strangeways, has thus cultivated tiny pieces of gristle from six-day-old embryos of fowl. During cultivation, they increased to more than three times their original length and developed along practically normal lines.

Besides growing, these test tube cultivations have actually manufactured a substance called phosphatase, an enzyme, which is of immense interest to biochemists, Miss Fell and R. Robinson of the Lister Institute, London, have reported. When the tiny pieces of gristle were taken from the embryo, they contained no phosphatase at all.—*Science Service.*

The "Hush Hush" Locomotive, An Unusual Design

THE London and North Eastern Railway Company, England, have just completed a new locomotive of unique design for use on their East Coast Route express passenger services, and a number of trials have been run.

In outward appearance this new engine is an entire departure from previous practice in locomotive design in England and many of the constructional details are novel. The boiler has been constructed to the extreme limits of the railway gauge and there is no room for a stack to project above the boiler. The stack has, therefore, been sunk within casing plates which are arranged to throw the smoke upwards and clear of the engineer's view from his position on the footplate.

Considerable experimenting was undertaken and the outstanding design was arrived at by tests which were made with a model of the locomotive in a wind tunnel with air currents of speeds up to 50 miles per hour. The results indicate a bold departure from the conventional appearance.

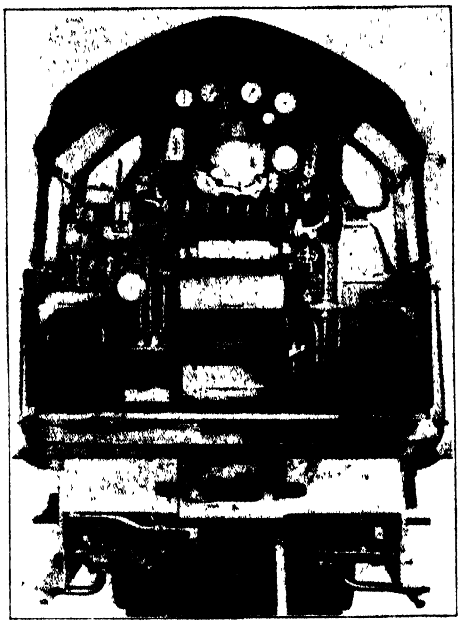
The locomotive possesses the unusually high boiler presure of 450 pounds per square inch, this being the highest pressure which has ever been used for a British railway locomotive. (The pressure hitherto used has been between 200 and 250 pounds.) This high pressure, which results in fuel economy, has necessitated the use of a boiler of the Yarrow water-tube type which has never before been applied to a locomotive.

The new engine possesses a 4-6-4 wheel arrangement known as the "Baltic" type, this being the first tender locomotive with this wheel arrangement to be constructed and operated in England. The six coupled driving wheels are six feet, eight inches in diameter.

One of the most striking features is that the whole of the air supplied to the fire-grate is pre-heated, the supply being taken from the front of the smokebox, passing down a space between the boiler and the casings.

The engine is a four-cylinder compound. The two high-pressure cylinders, which are made of cast steel, (a new feature) are 12 inches in diameter and 26 inches stroke driving on to the leading coupled wheels. The two low-pressure cylinders are situated outside the frames and drive the intermediate pair of coupled wheels. Each of them has a diameter of 20 inches and a stroke of 26 inches.

The new engine has been constructed according to the designs and inventions of Mr. H. N. Gresley, C.B.E., Chief Mechanical Engineer of the London and North Eastern Railway Company. The engine was constructed at the railway company's works at Darlington, the high-pressure water-tube boiler being supplied by Yarrow and Company of Glasgow, well known makers of marine water-tube boilers.



The cab of the L.N.E.R. locomotive shown below. The engineer sits at the controls at the left

No name has yet been given to this "hush hush" engine which after trials will be tested in actual service between London, King's Cross, and Edinburgh, Waverley.

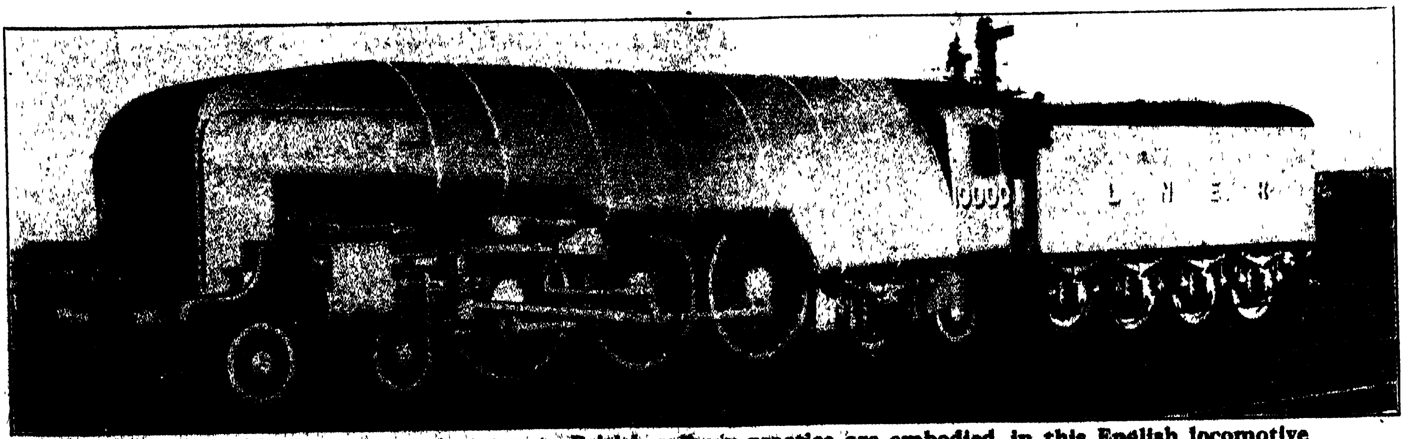
The engine is the longest and heaviest passenger locomotive in Great Britain, weighing, with its tender of the well known "Flying Scotsman" corridor type, nearly 170 tons.

Paper-Weight, Unbreakable Phonograph Records

"IS the 'Hit of the Week' out yet?"

"Yes, Madam," the newsdealer answers, and adds "It is a wonderful melody, too! I took one home last night and tried it out on my phonograph. Here you are. Fifteen cents please."

This conversation, mystifying to most



Principles of boiler construction new to British railway practice are embodied in this English locomotive people, may be a common occurrence in the near future when new phonograph records made of Durium which was recently invented by Dr. Hal T. Beans, Professor of Chemistry at Columbia University, are placed on the market.

This invention consists of a new product, a resinoid substance which is a liquid in its original form but when subjected to heat becomes an insoluble, infusible solid, which combines hardness and flexibility to a remarkable degree. A thin film of this substance, which has been named Durium, is so hard that it can scarcely be broken with an ordinary hammer and is almost as flexible as a piece of paper. Associated with Dr. Beans in the development of Durium have been Dr. Louis Hammett and Dr. Geo. H. Walden, Jr., also of the Chemistry Department of Columbia University.

Dr. Beans bends one of the phonograph records and pounds it with a hammer to show its durability

In making phonograph and sound-picture records by present methods, the plastic material of which they are formed is pressed in a heated mold so that a master die leaves its impression in the substance when it hardens. This is a slow process, however, because the metal molds must be cooled by artificial means before the molded record can be removed. The making of Durium records is simply a stamping process which may be practically as fast as ordinary mechanical printing.

The Durium phonograph record consists of a coating of only six or eight thousandths of an inch of Durium upon a heavy fiber paper. This paper is impregnated with Durium, passed through a drying room, cut into workable sections, passed rapidly through a stamping machine, and finally printed with titles in another machine. The die from which it is stamped is precisely the same as those used in making ordinary records.

As intimated in the first paragraph, these records, made in the company's own recording studio, will not be sold in music stores, but will be distributed to newsstands and sold therefrom for 15 cents each. Three celebrated figures in the world of music, Eddie Cantor, Florenz Ziegfeld, and Vincent Lopez have agreed to form a music jury to select the most popular song hit each week for recording.

The writer visited the Durium plant where he listened with amazement to the perfect tones of a Durium phonograph record which had already been test-played more than 200 times. The significance of this will be realized when it is known that the factory requirements for good tone reproduction of ordinary phonograph records is only 100 times. The writer also saw a Durium record hammered and scratched with great force with no apparent effect upon its tone quality.

Durium is being used at present for making "Hit of the Week" records and sound-picture records, but it is idle to speculate what its future uses in industry may be. Due to its heat-resistant quality it is effective for making matrices into which melted metal is cast, and since it can be applied with a spray, or with a brush, it may later be used as a paint where a fire-resistant waterproof surface is desirable—for example on the non-metallic parts of airplanes.

Preparing a "Square Meal" for the "Graf Zeppelin" in Brazil

AFTER the *Graf Zeppelin's* historic swing around the world in the almost unbelievable period of less than five days' flying time, it would seem that her forthcoming flight to Brazil and thence to the United States leaves little to stir the imagination. But such is not the case. A new difficulty, which for a time threatened to frustrate all the carefully conceived plans for this ambitious undertaking, set American engineers and chemists to scratching their heads in search of a solution.

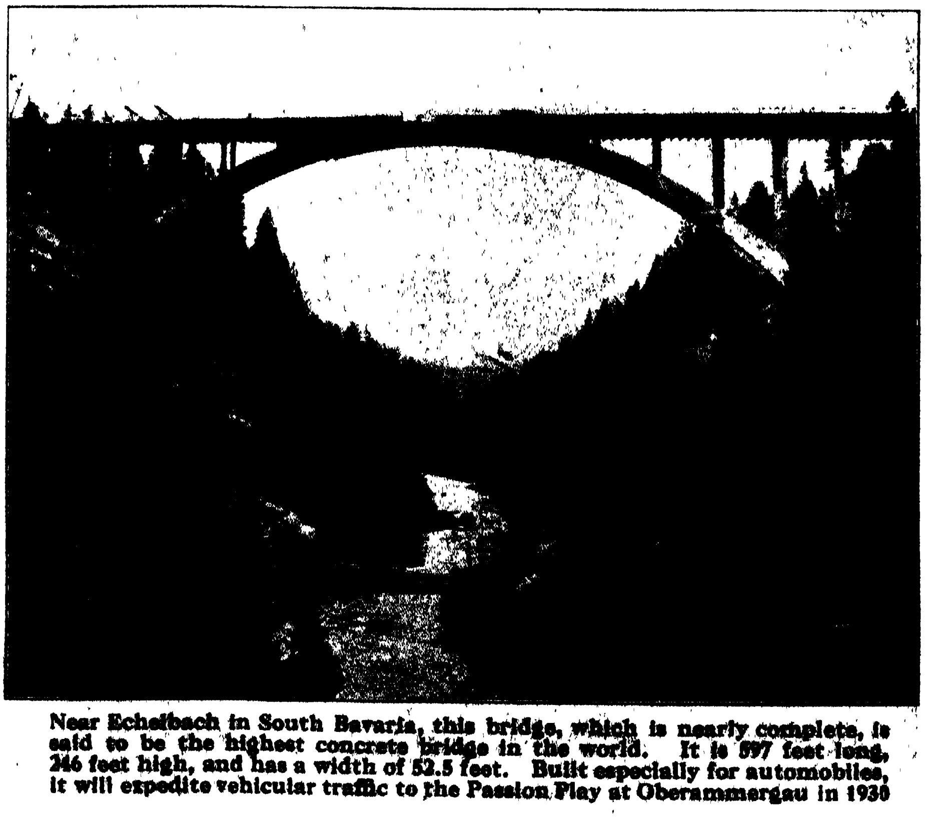
When the *Graf Zeppelin* lands at Pernambuco she will demand a "square meal" before turning northward to the United States. The American firm supplying both the lifting and fuel gas, the Carbide and Carbon Chemicals Division of the Union Carbide and Carbon Corporation, first assured the flight sponsors that the gases would be ready for them in Pernambuco, and then set about to find out how it could be done.

The Carbide and Carbon Chemicals Corporation had already perfected a fuel gas which had been used more successfully by the *Graf Zeppelin* on her previous flights than the blau gas originally used in Germany but now discarded in favor of the American type gas, even for use in Germany. This gas is a mixture of six parts hydrogen, and four parts Pyrofax. Pyrofax is a gas used commonly in the United States for cooking and lighting in sections not served by the gas mains. In refueling the Zeppelin in Tokio and Los Angeles, the Pyrofax was condensed to liquid form and shipped in tanks. Enough for the Brazilian refueling could be sent to Pernambuco in only 700 steel cylinders.

The hydrogen needed for combination with the Pyrofax has always been obtained at the refueling point. It is usually made in an electrolytic plant along with oxygen.

The refueling problem in Brazil seemed simple enough until it was learned that Pernambuco has no facilities for supplying hydrogen. The next difficulty encountered was the fact that to ship enough hydrogen to Brazil would require more than 4000 steel cylinders, more than could be spared in the entire United States. Furthermore, hydrogen cylinders may leak during the shipment and even if this were not so, the cost of shipping would be prohibitive. With no hydrogen available at Pernambuco and the impossibility of sending it there, Union Carbide officials were for a time checkmated.

But again lessons learned in the World War saved the day. Portable hydrogen generators had been successfully constructed and used during that crisis. This type of generator produces the hydrogen by the interaction of a caustic soda solution on ferro silicon in a covered tank. And so it happens that on two of these unpretentious looking generators, which have been built and are now on their way to South America, hinges the success of the entire undertaking. It is the first time since the war that a generator of this type has been used to any great extent, this time making



Near Echelsbach in South Bavaria, this bridge, which is nearly complete, is said to be the highest concrete bridge in the world. It is 597 feet long, 246 feet high, and has a width of 52.5 feet. Built especially for automobiles, it will expedite vehicular traffic to the Passion Play at Oberammergau in 1930 the long ocean voyage in the cause of science and man's conquest of the elements.

The problem of refueling the huge ship centers on the fact that the lift must be kept constant at all times. This must be accomplished, furthermore, without valving off and consequently wasting the levitating gas, which in the case of the *Graf Zeppelin* is hydrogen. Although the fuel supply naturally diminishes as the flight proceeds, the Zeppelin's weight must nevertheless remain constant. The *Los Angeles*, using the non-explosive helium for levitation, accomplishes this by condensing the water of combustion from her exhausts. The gas perfected for the *Graf Zeppelin* is, like blau gas, about the same density as air and therefore no change in weight occurs as the gas is consumed.

Watermelon Seed Makes Useful Drug

AN extract made from watermelon seeds and given the technical name of cucurbocitrin has proved its usefulness in relieving many cases of high blood pressure, Drs. T. L. Althausen and William J. Kerr of the University of California Medical School have reported. These scientists stated that their work confirmed the results obtained with the watermelon seed extract by its discoverer, Dr. I. S. Barksdale, of Greenville, South Carolina.—*Science Service.*

Manna of the Exodus was Plant Exudate

THE manna which the children of Israel ate during their sojourn in the Sinai wilderness was the sap of a desert shrub, the tamarix, drawn off and predigested by insects and dried to hardness in the desert air.

The vexed question of just what was this food, which seemed miraculous to the hungry refugees from Pharaoh's wrath, has been investigated by a special expedition sent out by the Hebrew University of Jerusalem, under the leadership of Dr. F. S. Bodenheimer and Dr. O. Theodor. A brief report of their results has been sent to the English scientific magazine *Nature.*

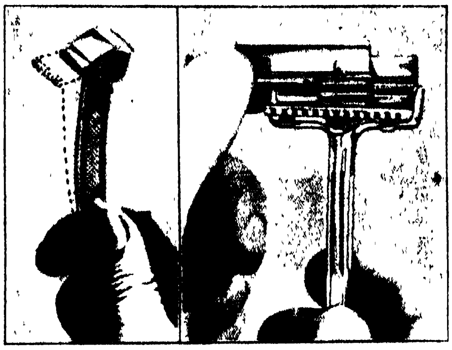
There has always been a dispute among scholars as to whether manna was an edible lichen, a low form of plant life that grows on the desert soil of the Sinai region, or whether it was the hardened sweet sap of the tamarix shrub. The studies of the expedition established that it is the same thing known elsewhere as "honey-dew"—the sap of the plant drawn off by aphids and exuded from their bodies. It is produced by one or two species of aphids on a single species of tamarix in sufficient quantity to form large drops that harden into sweetish grains of solid substance. Chemical analysis showed that it contains three varieties of sugar, as well as other compounds. —*Science Service.*

A Safety Razor That Sharpens Its Own Blade

AS you read the above title you will probably be as incredulous as we were when we first heard of it. Perhaps you will say "Impossible! Just a bit of hokum—another novelty to dupe unwise women looking for something new to give unsuspecting husbands." But we have examined this new safety razor thoroughly and it seems to be all that it is claimed to be.

Despite the fact that a great deal of research has been done on razors and safety-razor blades, very little is known concerning them. There is no formula by which a man with a certain type of beard may select a suitable razor. A man with a thickly growing beard may require a blade that has been sharpened with relatively large microscopic saw teeth, while one with a light beard may get a smooth shave with a wire edged blade, that is, one that has been sharpened down to an extremely thin and fragile edge. This new safety razor was designed to satisfy all types of beards. Because of the construction of this razor, which is produced by the DeHaven Razor Corporation, the edge is variable. The owner will, after a few mornings' experimentation, discover the edge most suitable to his particular beard and thereafter will sharpen his razor accordingly. Thus the razor has the quality of perpetual freshness.

In appearance, the DeHaven razor seems but a variation of a conventional type of safety razor with a single-edged blade. The frame consists of a handle proper, with an upper cap which holds the blade and which may be snapped open for cleaning or removing the blades. Inserted in a longitudinal slot of the main handle is a secondary handle which has a crossguard at the top just beneath the blade, and is pivoted at the lower end of the main handle so that it may be swung forward and backward in the main frame. Just beneath the edge of the blade on the guard is a piece of alloy steel which is roughened so that, when the swinging portion moves backward and forward, it hones the edge. The manufacturers supply a paste, to be rubbed on this honing surface, which contains a microscopic abrasive. A small amount of this paste wiped on the honing surface, a few jerks of the wrist, and the blade is sharpened.



At left: **sharpening the new safety razor by shaking.** ***At right:*** **removing the blade for cleaning**

Besides these features, the DeHaven razor is self-cleaning because when the movable part is flipped forward the underside of the blade is wiped clean. For final cleaning, the upper cap may be snapped back and the blade removed by sliding to one side. The stropping is always even due to the fact that the honing surface is swivel-mounted.

One of the generators which will "feed" the *Graf Zeppelin*

Australian Bushmen

HAVING purchased several months ago a photograph of a South African bushman with which a caption was supplied, erroneously describing him as an Australian bushman, we inadvertently allowed this error to be published. Realizing the mistake and having received from Mr. W. Lutge, Pinnaroo, South Australia, a letter on the subject, we desire to make amends and at the same time to correct the widespread impression that the Australian bushman is an aborigine. Part of Mr. Lutge's letter follows:

"It should be known that there is only one race of aborigines in Australia. They were of magnificent physique. They rarely interbred with the whites and are now nearly extinct. Colored people are so rare in Australia as to be regarded almost as a curiosity.

"The term 'bushman' is common enough and is synonymous with the American and Canadian 'backwoodsman.' In Australia, the bushmen are a fine type of white pioneers and belong to the class from which your much esteemed Lincoln was descended."

Learning to Use Our Wings

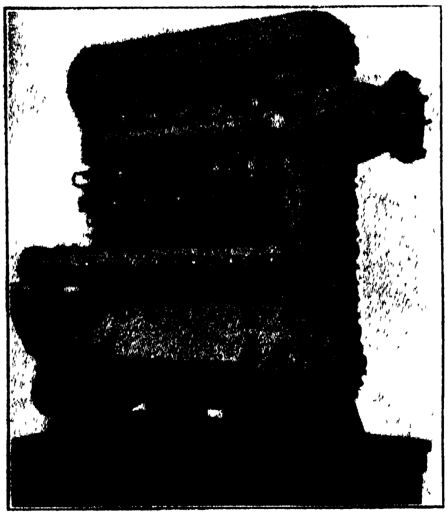
Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York City

The Junkers Diesel

AT the last meeting of the *Wissenschaftliche Gesellschaft für Luftfahrt* in Germany, Dr. Gasterstadt of the Junkers Company presented some preliminary information on the Junkers aircraft Diesel engine. A summary of this paper appears in a recent issue of *Automotive Industries*. The interest in aircraft Diesels is so keen at the moment that even partial information is valuable to us.



Side view of the Junkers Diesel aircraft engine, with the cylinders cast in a single block. The propeller shaft is geared to 2 crankshafts at the top and bottom

The engine is of the two-stroke double-piston type, originally developed by the Junkers company for stationary purposes. Thanks, in part, to the high piston speed of 2160 feet per minute, the engine weighs only 2.6 pounds per horsepower and develops a total of 650 horsepower. There are six cylinders arranged vertically in a single block of a light alloy of aluminum and silicon. Two crankshafts are used, one at the top and one at the bottom of the vertical cylinder block. The block includes not only the cylinders but most of the two crankcases and the gear case at the forward end. Roller bearings are used on the crankshafts to save weight and make the engine compact. Five spur gears at the forward end connect the two crankshafts to the propeller. At an engine speed of 1500, the propeller turns at 1100 revolutions per minute. A double duralumin piston controls the exhaust and inlet ports.

A supercharger blows the air into the engine at 17 pounds per square inch, through scavenging ports so shaped that the air enters tangentially and keeps up its swirling motion until the end of the compression stroke. The supercharger is of the centrifugal type with the impeller driven from the rear end of the crankshaft.

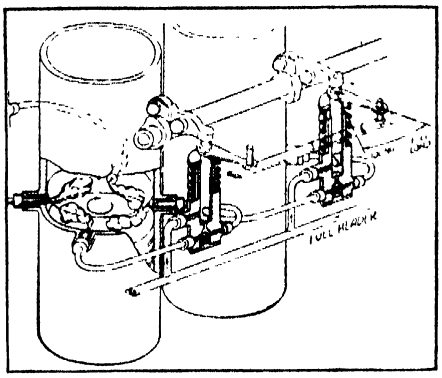
Four fuel nozzles are used for each cylinder, served by two pumps, one on each side of the cylinder. The nozzles are so shaped that the fuel leaves them in a fan-shaped spray inclined at 45 degrees to the piston heads. Owing to the quadruple spray and the swirling motion of the air induced by the inlet passages, there is a rapid intermixture of fuel and air, and low fuel consumption.

The fuel pumps are of straightforward design, with a simple mechanism for varying their stroke. The fuel consumption is only .365 pounds per horsepower, which is far less than that of a gasoline engine. The engine has seen 50 hours' flying service, including one non-stop flight of 8 hours' duration. Starting is accomplished by compressed air admitted to the engine cylinders, no special starting facilities being required.

An Interesting Ski

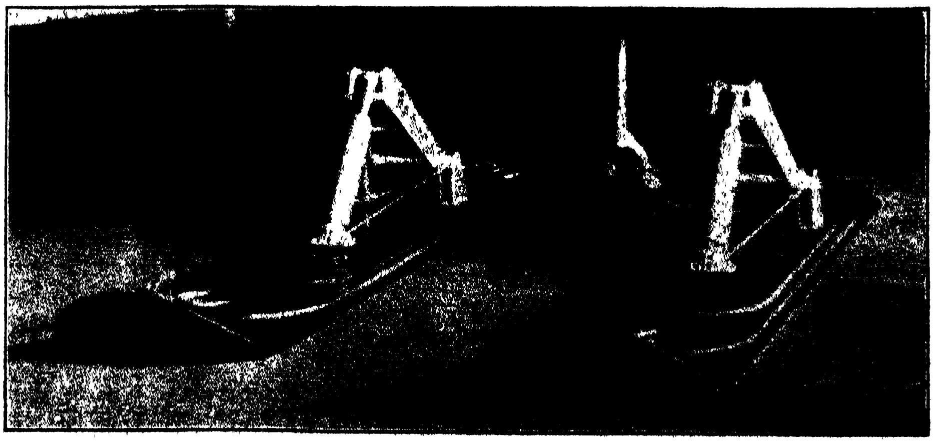
THE design of an airplane ski is a question of real engineering ability. The ski has to have such a surface that the impact on landing is sufficiently distributed, it must be able to stand up in rough landings, and it must be so pivoted that the airplane can change its attitude, as required, for the get-away or landing. The airplane landing gear employs shock-absorbing struts, and tires which are also capable of taking up shock. Hitherto skis have been built without the use of shock-absorbing devices but the Aircraft Products Corporation of America has now introduced a shock-absorbing member in its latest ski which is illustrated below.

The Junkers Diesel with crank-case and gear covers removed, showing, at right, the gears which transmit power to the propeller

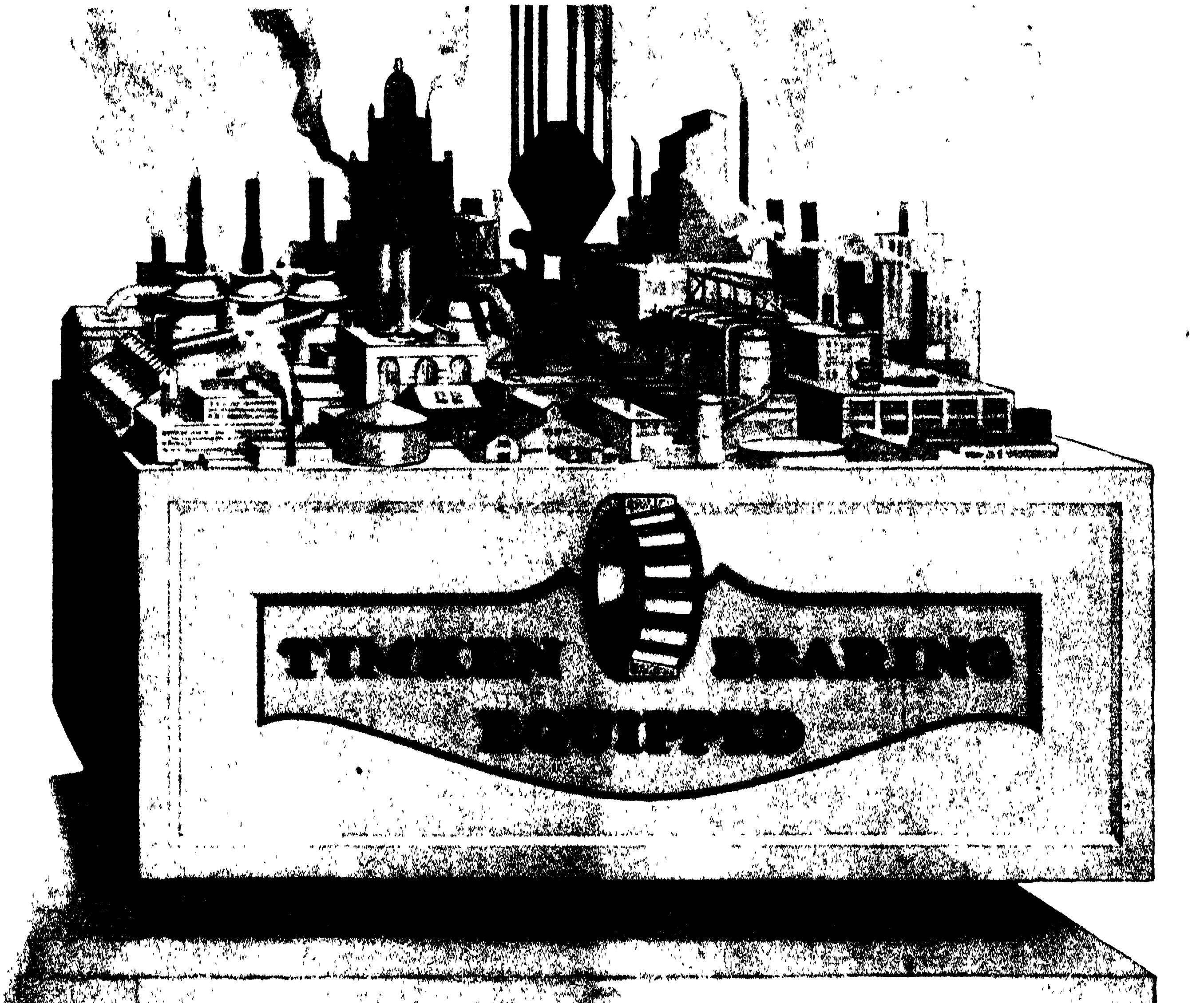


Fuel injection in the Junkers Diesel. Four nozzles, supplied by two pumps for each cylinder, supply a whirling spray which gives a quick mixture of fuel and air

The axle of the airplane is freely mounted in a rugged metal structure, the lower end of which is mounted on the after part of the ski, but which is free to turn about this lower end. Between this metal frame which is free to turn and the center of the ski proper, a shock-absorbing strut on the oil-hydraulic principle is introduced. Accordingly when the airplane lands, the shock is absorbed by the strut, which becomes shorter, while the metal frame moves down a little. The two coils of rubber cord at the front and rear ends of the ski are attached to the fuselage and prevent too great an angular motion of the ski as a whole. The introduction of shock-ab-



Airplane skis equipped with shock-absorbing struts



The Corner Stone of Industry

Friction or anti-friction is the difference between building upon a *sand* foundation or upon a *sound* foundation . . . "Timken Bearing Equipped".

Industry either lays itself wide open to Waste and pays a heavy friction-tax . . . or sets up a safeguard and reaps the resulting profits.

The kind of anti-friction protection is important . . . to select the bearing that carries *all* burdens, whether the load is all radial, all thrust, or both in any combination—the bearing that gives full protection based squarely upon Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made steel.

This group of exclusive Timken advantages puts production on a modern basis. Machine life becomes self-perpetuating. Power loss, lubricant and maintenance costs lose their significance and dwindle to decimals.

In lathe spindles or rolling mills; in steam shovels or mine cars or railroad trains—a wave of replacement surges over the nation—a protest against Waste—headed by the national symbol and safeguard—"Timken Bearing Equipped", the Corner Stone of Industry.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

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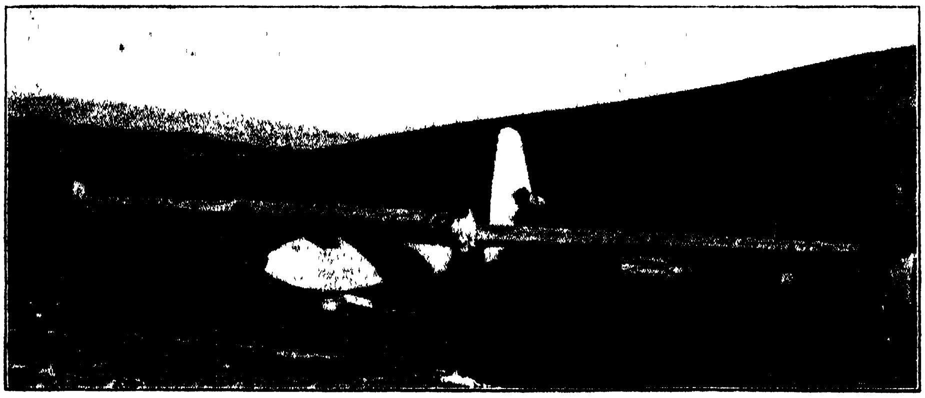
TIMKEN *Tapered Roller* **BEARINGS**

Above: A three-quarter front view of the Bellanca *Pacemaker* described below. *At Right:* Looking backward from the pilot's seat into the comfortable cabin

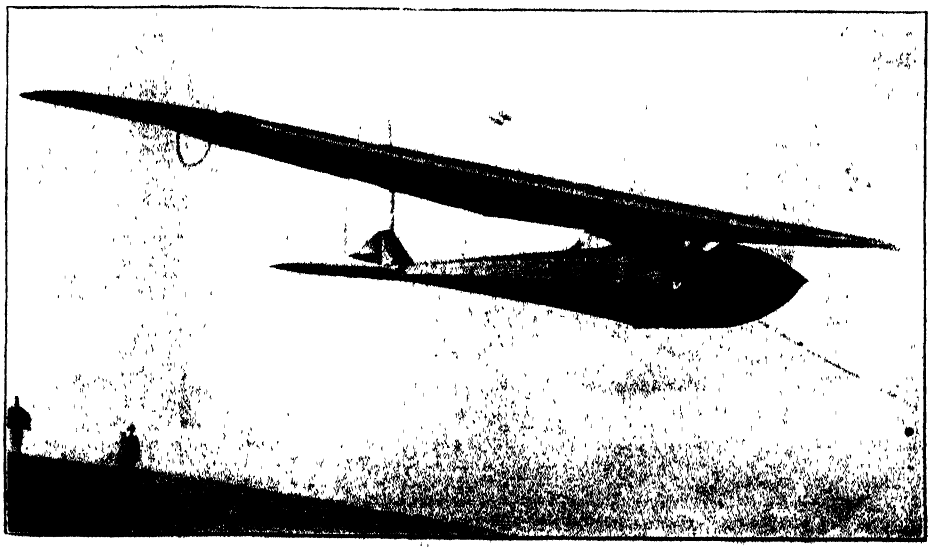
sorption in the ski is decidedly a step forward in cold weather operation.

Bellanca "Pacemaker"

AIRPLANE design has settled down to a steady process of evolution. There are no radical changes in appearance to be observed, but steady improvement in performance, carrying capacity, strength, and flying characteristics. Those of our readers who have seen the earlier Bellanca monoplanes will note from our photographs that the latest product, the *Pacemaker*, has apparently very similar features. The lifting struts, which combine the functions of bracing members with those of lifting surfaces, are still employed but there is a more graceful blending of wing and fuselage. The vision at the front end of the cabin almost attains perfection. The interior of the cabin, by skilful engineering, is freed of all obstructing structural members.



Lindbergh takes to gliding! ***Above:*** **Installing a new wing on the Bowlus sailplane glider.** ***Below:*** **The same glider just after the take-off, with Col. Lindbergh at the controls**

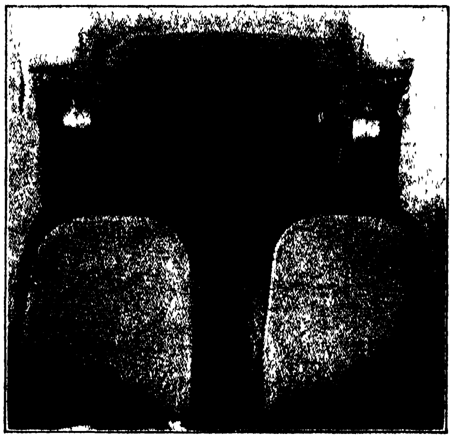


The performance and carrying capacity, as given by the company, are excellent. With a Wright J-6 of 300 horsepower, the *Pacemaker* has a useful load of 1937 pounds, which includes a pay load of 1042 pounds (pilot and 5 passengers), 112 gallons of gasoline, and 7 gallons of oil. Fully loaded the plane weighs 4300 pounds. The wing area is only 270 square feet. Even allowing for the lifting struts, the loading per square foot is high. Apparently our designers are willing to increase high speed even with the necessity of somewhat high landing speeds. Their argument is that the ever-increasing number of airports and landing fields makes the use of high landing speeds fairly safe.

The interior of the cabin is evidently quite attractive from the passenger's point of view. No effort has been spared to make the cabin of the *Pacemaker* as attractive and as comfortable as possible. The seats are built of light steel tubing, which makes them completely free from the weaving and deterioration of wicker chairs, and are covered completely by deep comfortable upholstery. The non-shatterable glass windows are equipped with silk roller shades and solid mahogany frames. The rear windows may be opened for ventilation. The cabin interior is upholstered in two tones of high-grade automobile fabric, light in shade above the belt line and slightly darker below. This combination of coloring aided by the large sky-light window in the top of the cabin gives a bright and cheerful appearance to the interior. The sky-light window also permits the pilot to see above and to the rear. Leather safety belts are provided on all seats and a heater keeps the cabin snug and warm in the coldest weather.

Teaching Elementary Aerodynamics

ONE of the most interesting educational developments of the day is the extent to which elementary aerodynamics, the science of air flow, is being taught to the youth of the nation. We would, of course, expect aerodynamics to be taught in ground and flying schools and in the universities and technical schools offering courses in aeronautical engineering, but what is remarkable is that aerodynamics is now an accepted subject in a number of secondary schools engaged in general education.



Since the science of air flow has many applications outside of aviation, as in windmills for generating power, in sailing vessels, in the determination of wind loads for buildings, in the streamlining of racing automobiles, and in the design of air fans of various descriptions, the spread of knowledge of this subject has value for the general industrial life of the nation.

While air is all pervading, it is generally invisible and therefore its laws are apt to appear mysterious. The instinct which enables us to understand mechanisms such as the wheel and the lever no longer suffices, and it is a matter of some difficulty to bring home fundamental principles to the student.

Theoretical exposition is insufficient and there must be methods available for visualizing air flow and forces. It is therefore gratifying to see a text specially devoted to "Elementary Laboratory Aerodynamics," written by Arthur L. Jordan, of the Polytechnic High School, of San Francisco, and published by the Ronald Press, New York.

This manual gives directions for laboratory experiments suitable for students of the ordinary high school, and assumes a knowledge of elementary algebra and geometry only. Apparently any wide-

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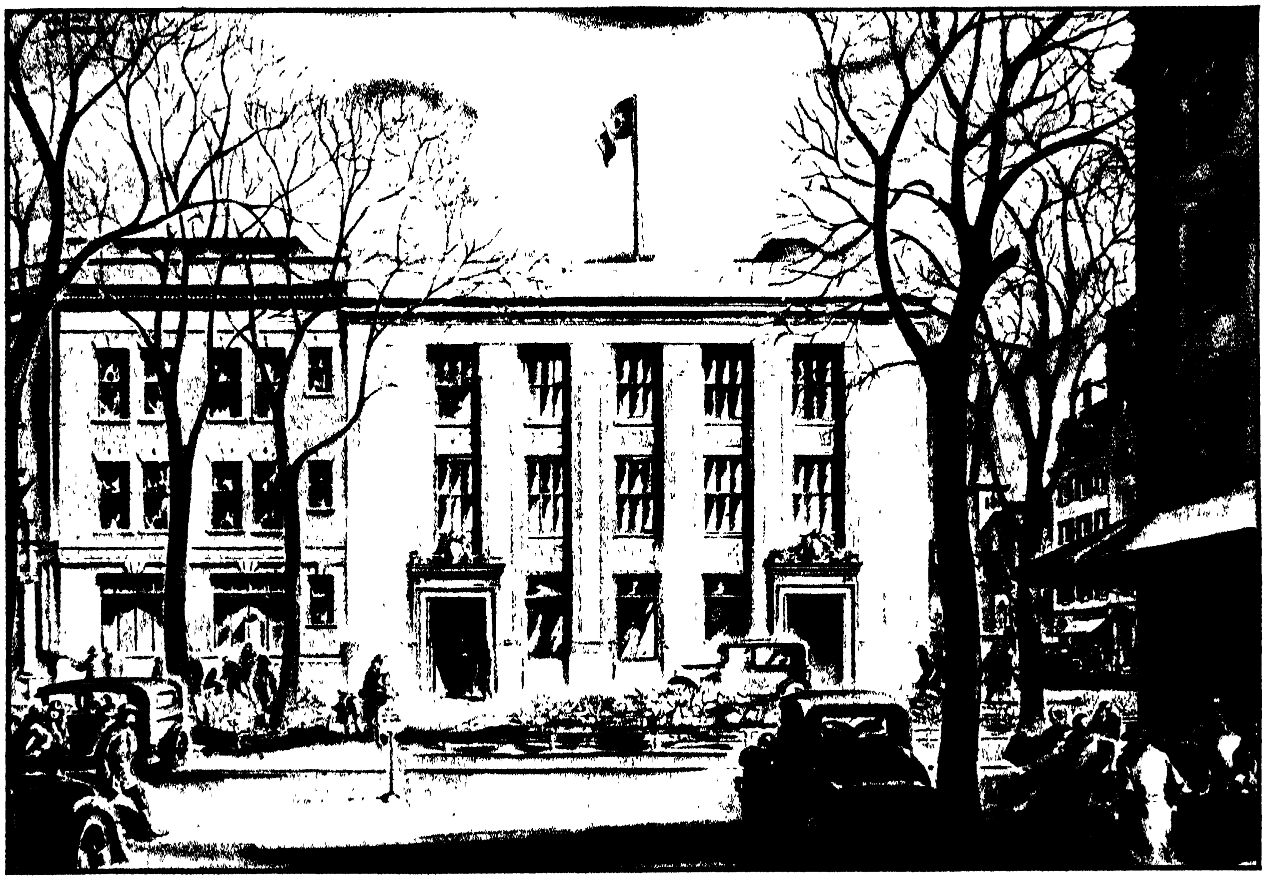

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The Bell Telephone Company . . . of your town

An Advertisement of the American Telephone and Telegraph Company

IT HAS its home in your town. Its operators are the daughters of your neighbors. Its various departments are in the hands of your own citizens, with years of training in telephone engineering and management. Who owns the Bell System? 450,000 people scattered over the United States own the stock of the American Telephone and Telegraph Company and 250,000 own other securities of the Bell System.

No matter how small the part of the Bell System that serves you, it has behind it research, engineering and manufacture on a national scale. The Bell System operates through 24 companies, each designed to fit the particular area it serves—to furnish the highest standard of service in a manner personal to the needs of every user.

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The Bell System's ideal is to give all of the people of this nation the kind of modern, convenient telephone service that they want, over its wires to connect them one with another and with the telephones of the rest of the world. It is your telephone company, at your service with every resource that it commands.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Gas Industry By-Product Aids Agriculture

SULFUR, for the agricultural market, must be of finely divided particle size. For years manufacturers of spray and dusting materials have striven to produce, economically, a sulfur the particle size of which would satisfy this demand. Plant pathologists have demonstrated by careful field tests that the efficacy of sulfur is determined by its fineness—the finer the particles, the quicker the oxidation and hence the toxicity toward fungous diseases, for sulfur is primarily a fungicide; a destroyer of those innumerable plant diseases found everywhere in nature, such as mildews, scabs, and "rots."

Manufactured gas contains hydrogen sulfide gas as an impurity. This hydrogen sulfide must be removed if the gas is to be used for domestic purposes. The problem of purifying gas has engaged the energy and time of the gas industry for many years. The industry's problem was to furnish a purified gas to the American home. When, however, it was finally solved, it was realized that a definite contribution to another industry had unintentionally been made. One of the products resulting from the purification of gas was elemental sulfur recovered in an extremely fine division. Here was the product desired by the plant pathologist—sulfur with particles of colloidal dimensions, wettable, easily suspended in water or in miscible oils, and obtained in this ideal physical condition without the necessity of mechanical grinding.

An idea of the fineness of this recovered sulfur is obtained from some comparative measurements which involve commercial competitive sulfurs. Recovered sulfur has particles ranging from less than one micron (0.001 millimeter) to 15 microns. Ground roll sulfur dust particles range from 50 to 200 microns.

The essentials of the process are explained by Vincent Sauchelli, of the Koppers Company Research Laboratories, in a recent issue of *Chemical Markets*. Raw gas as it comes from the carbonization process contains hydrogen sulfide and other impurities. The gas is passed through a specially prepared chemical solution. This solution absorbs the hydrogen sulfide and is led into tanks. These tanks are equipped with submerged pipes which have many orifices through which air is forced. This aeration causes a chemical reaction which liberates elemental sulfur. The air is forced into the solution in the form of minute bubbles through the tiny orifices. These air bubbles seem to have a particular attachment for the sulfur particles liberated in the solution. As a bubble attaches itself to a sulfur particle it lifts it to the surface. The result is a neat separation and flotation of the sulfur in the form of a froth or foam. The sulfur froth may become 6 to 18 inches deep and contain from 6 to 12 percent sulfur. A sufficient air pressure is maintained in the system to force the froth to overflow into troughs. In the trough the froth subsides through the formation and release of the larger air bubbles, leaving a creamy slurry which flows into a pit or tank. The slurry is then pumped into filter presses where the sulfur is recovered as a wet cake having about 50 percent water.

Excellent results have been reported from a large number of careful tests on the agricultural value of this new product.

Gas and Holder of Blimp Both Chemical Products

THE dramatic part of chemistry in the development of aviation was stressed in a paper presented at a recent meeting of the American Electro-chemical Society. Of prime interest among the many contributions of the chemist to the art of flying is the commercial perfection of a metal known as Alclad, from which the gas bag of the *ZMC-2*, the first all-metal dirigible, is constructed. This material consists of a sheet of duralumin coated with very pure aluminum. Thus, use is made of the strength of duralumin (an alloy of aluminum, iron, silicon, copper, magnesium, and manganese) and of the superior corrosion-resisting properties of pure aluminum. The outer pure aluminum is decidedly more resistant to corrosion than the strong aluminum alloys.

However, as Dr. Edwards and C. S. Taylor in their paper pointed out, when corrosion does occur, as for example at the exposed edges of the duplex metal sheet, it is at the expense of the protective aluminum coating and not of the alloy core. The pure aluminum is anodic to the duralumin core by as much as 0.1 to 0.2 volt, which apparently is sufficient under the circumstances to protect the core from the intergranular type of corrosion, to which certain of the heat-treated, strong aluminum alloys are subject.

The helium used in the Navy's latest "blimp," is also a product of recent chemical technology. This gas, formerly very rare and expensive, is now produced by the United States Bureau of Mines plant at Amarillo, Texas, from natural gas, where remarkable improvements in the process of manufacture have assured the Navy of adequate supplies of helium at reasonable cost. Latest figures indicate the cost to be $17.63 per thousand cubic feet of 97.7 percent pure helium. The capacity of the plant is approximately 850,000 cubic feet per month of the non-inflamable gas which supplies the "lift" for all United States Navy blimps and dirigibles.

Would Burn Coal Underground

COAL mining may become a lost art if time proves the practicability of an idea of Leo Ranney, well-known in coal and oil refining circles. Mr. Ranney proposes to set fire to the coal deposits and allow the fuel to burn underground, piping the resultant gases to the surface. Patents to cover the process have been applied for.

Mr. Ranney explained that by controlling the burning coal, either petroleum or carbon dioxide may be produced. From the former, he said, gasoline can be refined;

A view taken in the chemical department of the plant of the Toyo Match Company at Kobe, Japan. Here the "heads" are put on "Made in Japan" matches at the tremendous rate of 300,000,000 dozen boxes per year. Modern machinery is used in the various processes throughout this plant

FOUND . . .

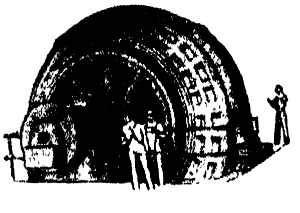
a way to improve ALADDIN'S LAMP

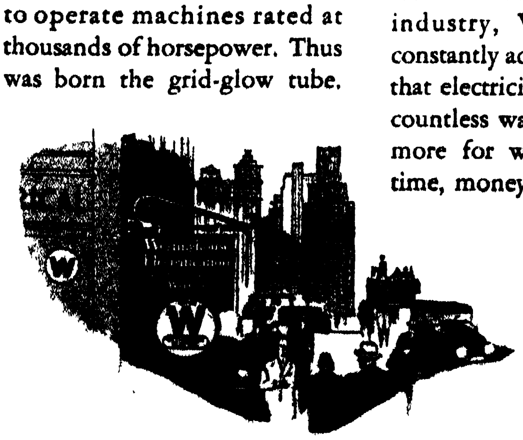
LESS than three years ago a row of glow tubes sat in a test rack before a window in the Westinghouse research laboratories at East Pittsburgh.

D. D. Knowles, research engineer, glanced at them one morning and noticed that some of the tubes quite unexpectedly were glowing, while others were not. Some tubes glowed when the sun was shining and went dark on cloudy days; others responded when a hand touched the glass.

It was quickly recognized that an important new electrical development had come to light. Thousands of tubes were made and tested. Shapes of various parts were altered until a relay was available—so sensitive that a tiny pulsation of energy, less than that expended by a fly walking on a window pane, was made to control enough current to operate machines rated at thousands of horsepower. Thus was born the grid-glow tube. Because of this development a hand waved lightly over a crystal ball in New York City started giant motors in the Homestead Steel mills hundreds of miles away. Aladdin's lamp, which had to be rubbed to get results, is outrivaled by the grid-glow tube which responds to a mere wave of the hand.

To magnify human capacities is the daily work of the Westinghouse organization. In research, in the design of electrical and allied equipment, in the application of electrical power to new tasks, in the distribution of electrical apparatus for homes, business, and industry, Westinghouse is constantly active . . . to the end that electricity may continue in countless ways to help you get more for what you spend of time, money, and energy.





ELECTRIC POWER BUILDS BUYING POWER

Westinghouse

while from the latter, dry ice can be manufactured—both at low cost. It was further explained that the gas can be piped to the consuming area or burned at the mouth of the mine and used to generate electricity.

While he did not reveal the workings of his process specifically, Mr. Ranney said the first production work would start either in Illinois or Pennsylvania.

Mr. Ranney is the inventor of a system whereby oil fields abandoned as completely drained can be made to yield further through the drying of subterranean sands. These patents are owned by the Standard Oil Company of New Jersey. His latest process is said to terminate many years of experimentation in the oil industry, in attempts to control gas generated by burning coal underground.

"The World's Worst Fire"

THE photographs show successive stages in the combating of what is known as the world's worst fire—a blazing pool of highly inflamable liquid, such as oil or gasoline, into which a stream of new fuel is flowing as it burns. Of the several modern methods of fighting fire which chemists have developed in recent years, none so effectively combats a conflagration of this kind as the "blanketing" method, whereby a stream of foam is spread over the blazing liquid, shutting off its supply of oxygen.

These pictures show a demonstration of the "Foamite" system now widely used in the oil fields, in which two cans of gasoline were punctured and set afire. The last picture shows clearly how the dense foam piles up over the fire and extinguishes it, even though a stream of gasoline is still running out of the upper can.

Asphalt Emulsions Find Uses

ASPHALT, generally associated with road paving, has begun an invasion of a wide variety of manufacturing processes as a result of the discovery that this material can be used as a water emulsion. Asphalt is insoluble in water and heretofore it has been applied either by heating it until it melts or dissolving it in inflammable solvents.

When applied by heating there are fire hazards and danger to workers; also, serious impairment of the asphalt may take place as a result of careless heating. When applied by means of a solvent, there are the disadvantages of fire hazard, obnoxious fumes, inability to obtain a thick coat, and the necessity for a moisture-free surface. Emulsified asphalt overcomes these disadvantages very effectively, as shown by an article by Lester Kirschbraun in a recent issue of *Chemical and Metallurgical Engineering*.

In the emulsification operation the asphalt is dispersed in water, as exceedingly fine particles, upon which the emulsifying agent is most probably absorbed as a protective layer. The emulsifying agent may be any of a number of substances, but it has been found that the use of a selected clay-like mineral produces a dispersion satisfactory for a large variety of industrial purposes.

Unlike paints, asphalt emulsions can be made totally suspendable so that they be shipped to distant points in large drums without any danger of settling out. The material can be mixed with cement, acids, salts, other electrolytes, fibers, pigments, and so on. The application requires no heating and it is only necessary to permit the coated material to lose its water by evaporation.

***Above*: A demonstration of Foamite; *below*, a view of an oil fire, in the Goose Creek Texas, field**

The dried coat left is irreversible—that is, it will not re-emulsify when placed in water. It will adhere to surfaces to which asphalt generally adheres, and to others such as water-wet surfaces, cement, and wood.

One of the most interesting uses of the emulsion is as a binder in mastic flooring. The emulsion, containing fiber uniformly incorporated, is mixed with Portland cement and sand. Such materials are particularly adaptable for factory floors, trucking aisles, loading platforms, ship decks, driveway patches, and railroad car floors. Due to their resiliency and toughness these floors improve as traffic rolls over them. Forty-eight hours after such floors are laid, they will take care of heavy trucking. Their maintenance and repair are accomplished with ease.

During the past few years asphalt emulsions have been incorporated with success in moistureproof and waterproof paper. As carried on commercially the emulsion is handled with the paper stock by pumps and may be introduced into the paper-making system either by admixture with fiber in the beater or at the paper machine.

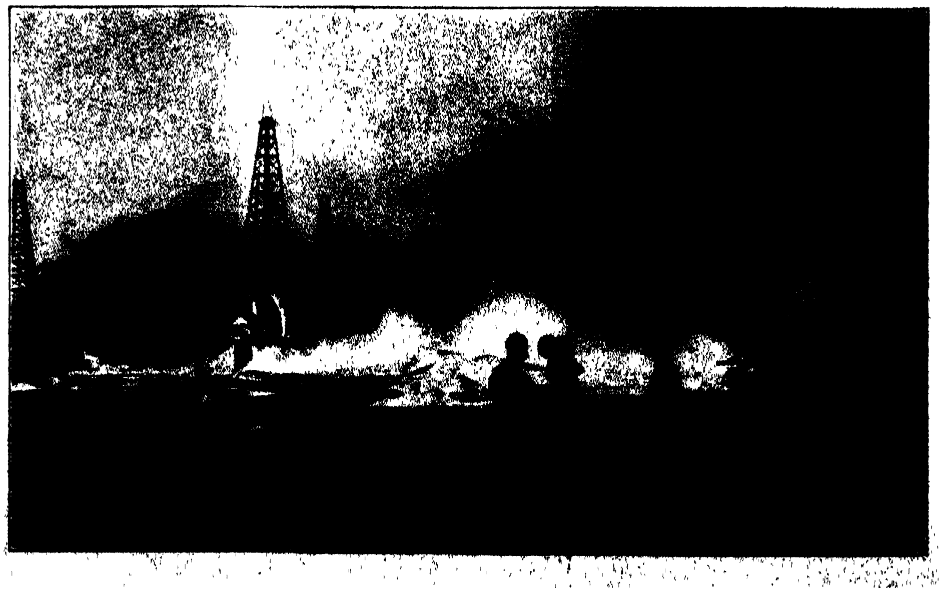
A wide variety of products has already been introduced and others are being perfected. These products include floor tiles made on a wet machine; thermoplastic boards; molded products such as pails, tubs, and the like, in which a mixture of asphalt emulsion and pulp is sucked onto molds; sheathing paper; mulch paper; moisture-proof board for containers to be used for foodstuffs, soaps, and other commodities in which it is desired to minimize the effects of change of moisture content.

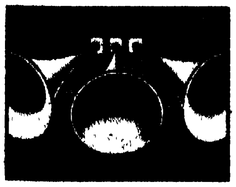
One of the most important uses of asphalt emulsions is as protective coatings on structural steel and on pipe lines.

Cream-Separator Principle Widely Applied in Chemistry

THE centrifugal cream separator is familiar to everyone who has ever seen a dairy, but comparatively few people realize that the same machine plays an important role in many chemical operations far removed from the farm. Not only is the centrifugal principle applied to the separation of two liquids of different specific gravities, but it is just as useful in removing suspended solids from a liquid.

(*Please turn to page* 326)





Everywhere at the same time!

Public Address System brings speaker right to you — The speaker rises—and the Western Electric installation in the huge room transforms him into a score of speakers! No matter how far away from him you sit, his every word comes to you as distinctly as though he stood right beside your chair.

Committees arranging banquets or conventions find that meetings are more interesting and effective when held in hotels where the Public Address System widens the hearing circle.

This equipment is a miniature interior broadcasting station, transmitting speech, music and entertainment *within* a building—to as many rooms as desired. Patrons of hotels thus equipped find an added attraction in getting music "on tap" in their rooms via loud speaker.

In up-to-date schools, hospitals, railroad stations and amusement parks, too, you will find the Public Address System adding to convenience and enjoyment. Made by your telephone makers, it assures the faithful tone and dependable service for which Western Electric sound transmitting apparatus has been known for over half a century.

Western Electric

PUBLIC ADDRESS SYSTEMS

MADE BY THE MAKERS OF YOUR TELEPHONE

Distributed by Graybar *Electric Company*

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Agriculture

The Use of Explosives in Blasting Stumps, Department Circular Number 191, contains 21 "dont's" for prospective blasters, with recommendations and instructions. *U. S. Department of Agriculture, Washington, D. C.—Gratis.*

The Progress of Biological Control of Prickly-Pear (Cactus) in Australia, by Alan P. Dodd, discusses the operations of the Commonwealth Prickly-Pear Board in its efforts to control the pest. This American plant has taken possession of about 65 million acres in Australia. *Commonwealth Prickly-Pear Board, Brisbane, Queensland, Australia—Gratis.*

Reindeer Grazing in Northwest Canada, by A. E. and Robert T. Porsild, is a well-illustrated report of a botanical expedition of great importance. The authors covered about 15,000 miles by dog team, canoe, motor boat, pack dogs, and snowshoes. They brought back what is probably the largest single botanical collection ever made in Arctic America, many zoological specimens, and about 1000 photographs. The United States Bureau of Biological Survey and other American agencies co-operated in the investigation. *Department of the Interior, Ottawa, Canada—Gratis.*

Electricity

Bell Laboratories Record, Cumulative Index to Volumes One to Seven Inclusive, lists by authors, subjects, and titles, the numerous research papers published between September, 1925, and August, 1929, inclusive. *Bell Telephone Laboratories, Inc., 463 West Street, New York City—Gratis.*

Public Service that Protects Property and Lives in the Electrical Field is the title of an illustrated booklet describing the high standards insisted upon by workmen pledged to adhere to the Electrical Code. *Electrical Workers' Union No. 3, 130 East 16th Street, New York—Gratis.*

Hydro-Electric Progress in Canada During 1929, Bulletin Number 1353, contains brief descriptions of all important water-power developments under construction during 1929. Undertakings now under construction, it shows, will add more than 1,600,000 horsepower during the next three years. The total for the Dominion now is 5,727,600 horsepower. *Dominion Water Power and Reclamation Service, Ottawa, Canada—Gratis.*

Lighting Fuse, by F. P. Griswold, shows the best methods of doing this type of work, and describes various types of fuse lighters. This leaflet is one of the Explosives Service Bulletins which are issued from time to time to keep explosives users posted on the latest improvements in the technique of handling explosives and blasting accessories. *E. I. DuPont de Nemours and Company, Inc., Wilmington, Delaware—Gratis.*

Metals

Oxwelded Construction for Modern Piping Services is an illustrated booklet describing the welding of steel and wrought iron piping for a wide variety of industrial applications. *Linde Air Products Company, 30 East 42d Street, New York City—Gratis.*

In Harmony with Modern Progress illustrates instances in which pressed steel can be used to advantage in manufacturing various types of goods or equipment. *Geuder, Paeschke and Frey Company, St. Paul Avenue at 15th Street, St. Paul, Minnesota—Gratis.*

Problems and Practices of Modern Steel Treating is a well-illustrated booklet containing a summary of 23 heat treatment processes used in steel production. Each process is described briefly, the treatment best suited to the need is outlined, and the types of furnaces and instruments used are shown. *Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia—Gratis.*

Centrifugal Concentration: Its Theory, Mechanical Development and Experimental Results (Technical Paper 457) reports the findings in an investigation conducted by the Bureau of Mines. Preliminary tests show the process to be a promising one, particularly for treating tailings from mills using gravity-concentration methods. *U. S. Government Printing Office, Washington, D. C.—10 cents.*

Sanitation

Municipal Sanitation is a new monthly magazine designed to serve an important field, with the intention to promote more sightly and more healthful towns, cities, counties, and states. *Municipal Sanitation, 225 West 34th Street, New York City—One dollar a year.*

Report of the Westchester County Sanitary and Sewer Commission covers the activities of the Commission in charge of one of the country's most notable suburban expansion projects, involving the installation of some of the most modern sewage treatment plants yet constructed. *Westchester County Sanitary Sewer Commission, Court House Annex, White Plains, New York—Gratis.*

Science

High School Science Library for 1928-1929, by Hanor A. Webb, is a classified bibliography designed to fit budgets of various sizes. Each book of the list is described briefly. *Journal of Education, George Peabody College for Teachers, Nashville, Tennessee—10 cents.*

Serpents of the Eastern States, (Bulletin No. 3, Vol. XXXII) by Raymond L. Ditmars, is a comprehensive study of the harmless and dangerous snakes in the region covered, which includes New England, parts of New York and Pennsylvania, and New Jersey. *New York Zoological Park, New York City—Gratis.*

Miscellaneous

Thermal Properties of Petroleum Products, by C. S. Cragoe (Bureau of Standards Miscellaneous Publication Number 97), is a paper containing the results of a critical survey of existing data on this subject, a project of the American Petroleum Institute. The tables contain what appear to be the most reliable values available. *U. S. Government Printing Office, Washington, D. C.—15 cents.*

Literature of American School and College Athletics (Bulletin 24) is a bibliographical study following the Foundation's famous Bulletin 23 entitled, "American College Athletics," which revealed the professionalism prevalent in intercollegiate sports. Professor A. Carson Rayon, of Swarthmore College, is the author of Bulletin 24. *Carnegie Foundation for the Advancement of Teaching, 522 Fifth Avenue, New York—Both gratis.*

Photographing Invisible Writing is the title of an item reprinted from the *Literary Digest,* explaining the part ultra-violet rays play in detecting the original writing on old parchment manuscripts. With this description is sent a catalog listing the latest types of ultra-violet light equipment and auxiliaries, quartz laboratory apparatus, and laboratory furnaces, for use in studying fraudulent paintings, sculptures, antiques, minerals, and other materials or objects. *Hanovia Chemical and Manufacturing Company, Chestnut Street and Railroad Avenue, Newark, New Jersey—Gratis.*

Bilby Steel Tower for Triangulation, Special Publication Number 158 of the U. S. Coast and Goedetic Survey, gives full descriptions of the new-type towers and other equipment and apparatus used by government engineers in making surveys. *U. S. Government Printing Office, Washington, D. C.—15 cents.*

NEW YORK LIFE INSURANCE CO.

51 MADISON AVENUE, NEW YORK CITY
(INCORPORATED UNDER THE LAWS OF NEW YORK)
A MUTUAL ORGANIZATION FOUNDED IN 1845

EIGHTY-FIFTH ANNUAL STATEMENT

TO THE POLICY-HOLDERS:

I wonder if you know how important you with other Policy-holders have collectively become in the economic life of the world. You think of your life insurance as an important factor in your plans for yourself and your families but I doubt whether you yet comprehend what you are actually doing for the world at large.

I am speaking to you now as a part of the 70,000,000 people insured in all companies in the United States and Canada. I am speaking to you as part owner of the $19,000,000,000 which has actually been assembled for the protection of beneficiaries under the $110,000,000,000 of coverage which now exists. Never before in the history of the world have individuals voluntarily, privately and co-operatively pledged such a sum for mutual protection or for any purpose.

This coverage exceeds the total resources of all the banks in the United States and Canada, including savings banks, by about $34,000,000,000. It is equal to all the resources of all our Foundations and Endowments for Education and Research, multiplied many times. Our educational, medical, scientific and charitable institutions are in the hands of trustees whose powers are wisely limited by the terms of the instruments on which the trusts rest. The Trustees of these foundations seldom have any very wide discretion as to how funds under their control shall be distributed. Neither have we.

New York Life Insurance Company
BALANCE SHEET DEC. 31, 1929

ASSETS		LIABILITIES	
Real Fstate Owned and First Mortgage Loans on Farms, Homes and Business Property..	$593,633,002.37	Reserves—ample with future premiums and Interest to pay all insurance and annuity obligations as they become due. -	$1,465,664,828.22
Bonds of the United States, Other Governments, States, Cities, Counties, Public Utilities, Railroads, etc...	672,665,159.31	Dividends Payable to Policy-holders in 1930 . .	71,796,857.00
Preferred and Guaranteed Stocks.. .	52,414,042.00	All other Liabilities	7,859,164 31
Policy Loans, Cash and Other Assets	346,991,407.36	Total Liabilities. ..	$1,545,320,849.53
		General Contingency Fund.	120,382,761.51
Total Funds for Policy-holders' Protection	$1,665,703,611.04	Total ...	$1,665,703,611.04

Outstanding life insurance ($110,000,000,000) is the greatest trust ever created. It, too, is managed by Trustees. The Trustees are the Directors of the various companies with whom continuously sit certain familiar figures. They are Life, Death, Disability, Necessity and Old Age.

Death has heretofore been a terrible figure because life was not organized against him. Now life is so organized. Death will ultimately come to all of us. Nobody doubts that and nobody can change it. The terror of Death (I am not now considering any religious question) lies in his cruel, remorseless and uncertain stroke. In that has been his victory.

Life Insurance faces Death not as a Terror but as a fact and deals with him just as it deals with bonds or real estate mortgages.

Let me show you how vital those $110,000,000,000 are. Back of these pledged billions lie three great forces.

First—the $19,000,000,000 in cash and securities in hand;

Second—the seventy million people who have contracted, directly or indirectly, to pay future premiums;

Third—the power of compound interest.

Together they make that $110,000,000,000 the most vital and useful force in all sociology.

Now try to visualize what is coming. Outstanding Insurance will become $200,000,000,000, $300,000,000,000, possibly much more, but it will always have those three great forces, the first two correspondingly increased, behind it. Because of its peculiar relation to the weaknesses and needs of human life it is and always will be worth more than a like sum in cash. To illustrate—

Death sits with this great Board of Trustees and Death still strikes but, in your case, not as of old. Life also sits with the Board and by quickly translating individual productive power into cash it despoils Death of his old and faithful servitor, Poverty.

Disability, crueler than Death, also sits with that Board and demands and receives stipulated sums when the bread winner fails and becomes a burden.

Necessity and Old Age also sit with that Board and are covered by the underlying instruments.

All these benefits are specified in the Great Deed of Trust: the policies in force.

Some of you, most I hope, will agree when I say that Life Insurance has come to be the most important beneficial enterprise in the manifold problems of living.

My main point is that you, beginning with your individual needs and obligations, have not only minimized the terrors of Death, Disability and Old Age but you have come, as a group, to be one of the largest holders of useful securities in the world.

You are the only group that ever existed having the courage and sanity in the current problems of living to rob Death of his terrors by dealing with him as an ultimate fact.

As a group you are not capitalists, yet you have become the greatest of capitalists.

Following your impulse of self-protection you have created the greatest of all beneficial institutions.

Seeking to banish the need of charity from your own household, you have shown how the need of charity may be completely banished from every household.

DARWIN P. KINGSLEY, President.

DIVIDENDS Payable in 1930	NEW BUSINESS 1929	TOTAL RESOURCES Dec. 31, 1929	Insurance in Force Dec. 31, 1929
$71,775,000	$953,000,000	$1,665,000,000	$7,266,000,000

Branch Offices in most of the Larger Cities of the United States and Canada.

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.

Editor of the Journal of the American Medical Association *and of* Hygeia

Carbon Monoxide Poisoning

A SPECIAL committee appointed by the American Medical Association to consider the cases of poisonous gases in industry has just made its first report which covers particularly the use of carbon monoxide and its dangers. The committee consists of: H. Gideon Wells, M.D., chairman; Yandell Henderson, Ph.D.; Paul Nicholas Leech, Ph.D.; Carey P. McCord, M.D.; and L. R. Thompson, M.D. It is pointed out that poisoning by carbon monoxide gas is one of the hazards of modern life that can never be entirely eliminated because the generation of that gas is associated with the operation of automobiles and stoves, the combustion of wood, and the manufacture of many products. Whenever wood, coal, or petroleum products are burned, carbon monoxide may be a by-product. If a coal fire is lighted and the coal is too deep for air to pass easily, or if the air supply is checked in any way, carbon monoxide may be produced by taking away some oxygen from the carbon dioxide developed in the lower layers.

Manufactured gas in most cities contains about 20 percent of carbon monoxide and burning a flame near a cooking utensil or a pipe containing cold water stops the combustion at its first stage and liberates large amounts of carbon monoxide. Cooks working over stoves are sometimes affected with headaches as a result of inhaling too much carbon monoxide. This danger can be reduced by increasing the distance between the opening of the gas burner and the cooking utensil. The cooking utensil filled with cold water should be just above and not in the visible flame.

The chief source of deaths and poisoning from carbon monoxide is illuminating gas, and the prevention of such deaths must depend largely on better inspection of devices used in the handling of illuminating gas.

There have been a number of deaths, particularly in the winter months, from the carbon monoxide in automobile exhaust gas. Every year before cold weather begins drivers of cars must be warned again about starting the engine of an automobile before opening the garage doors. For a little while it is more comfortable to have the garage doors shut, but in the same little while the person becomes unconscious from inhaling carbon monoxide and unless he is discovered in time, he will die of the effects. Recent evidence indicates that even in the streets people inhale enough carbon monoxide on some occasions to make them sick. When inhaled, this gas produces headache and nausea, and no one really knows what the effect of repeated intoxication to a mild degree may be if continued over a period of years. Various attempts have been made to develop methods of preventing the exhaust of carbon monoxide from the automobile, but thus far no practically successful method has been developed.

When a person becomes a victim of carbon monoxide poisoning, the first thing to do is to give him immediate artificial respiration. He should also inhale a mixture of oxygen and carbon dioxide until his pulse and temperature are normal. He should be kept warm and prevented from making any muscular effort, because in his weakened state this may be fatal. Simple attention to the dangers that have been mentioned is bound to diminish accidents as a result of this new hazard of modern life.

Dislocations of the Neck

EVER since chiropractic took the basic idea of osteopathy and launched it as a separate science, there has been a good deal of general interest in dislocations of the bones of the spine. The actual fact of the matter is that the spinal bones are ordinarily so well held in place that any dislocation must be brought about by a considerable force.

When there is an actual dislocation of a spinal bone, the results may be exceedingly serious. In several cases described by Dr. Mitchell Langworthy before his recent death, the symptoms were exceedingly severe. A woman aged 55 fell down stairs, striking her head on the floor. Her neck became stiff and caused great pain. In her case the X-ray showed that the second vertebra in the neck had slipped forward. Her neck was straightened out by proper manipulations and held in place by sand bags put around her head while she lay quietly. She stayed in bed two weeks but had some stiffness in her neck for three months after the manipulation.

A man 33 years old was given a sudden jerk in an automobile accident. He had immediate pain and stiffness in the neck and weakness in the use of his arms. Some bones in his neck were discovered to be out of place and by proper scientific manipulation and the subsequent use of a plaster cast he recovered, although after many months he still has limitations in his neck movements.

Another type of cause of such accident was that which was responsible in the case of a boy five years old who was grabbed by a big boy about the head and shaken. The next day his parents noticed that his head was crooked and his neck stiff. An X-ray showed that the bones of his neck had been dislocated. By manipulation, the bones were thrown back in place and he had to wear a plaster cast for three weeks before it remained in place.

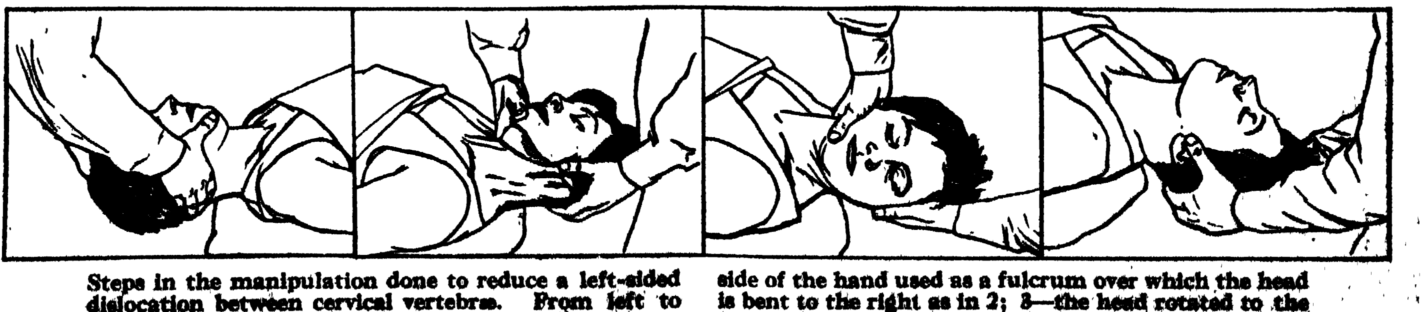
In Doctor Langworthy's discussion of the subject he illustrates the manipulations necessary to restore such dislocations in some cases, and from these pictures one can see how highly technical and serious a matter this really is.

The Gerson Diets in Tuberculosis

NEWSPAPERS have recently contained much concerning the diets developed under the famous German physician Sauerbruch and Doctor Gerson in Munich for the treatment of tuberculosis. In order to check the claims made by the German investigators, Drs. Edgar Mayer and I. Newton Kugelmass at Saranac Lake submitted 30 patients to similar methods. These were patients with far advanced tuberculosis of the lung who had previously been given all of the various special methods of treatment, but without success.

Patients with tuberculosis must be supplied with 50 calories per 1000 grams of weight, or 50 calories per day for every two pounds of weight. The diet must contain all of the important vitamins. The waste which takes place in tuberculosis tends also to rob the body of its important mineral salts, such as calcium, magnesium, potassium, phosphorus, and sulfur. The diet planned by Gerson proposes to take particular care of this demineralization and also to supply the body with the essential vitamins.

The German investigators were inclined



Steps in the manipulation done to reduce a left-sided dislocation between cervical vertebræ. From left to right, the illustrations show in proper order: 1—the side of the hand used as a fulcrum over which the head is bent to the right as in 2; 3—the head rotated to the left; and 4—head hyper-extended to prevent redislocation.

to emphasize that the Gerson diets had acid-forming qualities, whereas the controlled investigations at Saranac Lake indicated that the diet was primarily base-forming in character.

Under the Gerson diet, eight patients of the 80 gained in weight; ten showed some diminution in the quantity of sputum, and four, a lessened fever, whereas two who had not previously had fever developed it. Eight patients showed some clearing in the lungs and two with intestinal tuberculosis lost the symptoms of this complication. There was some diminution in the amount of fatigue, in the pain in the chest, and in the symptoms of tiredness.

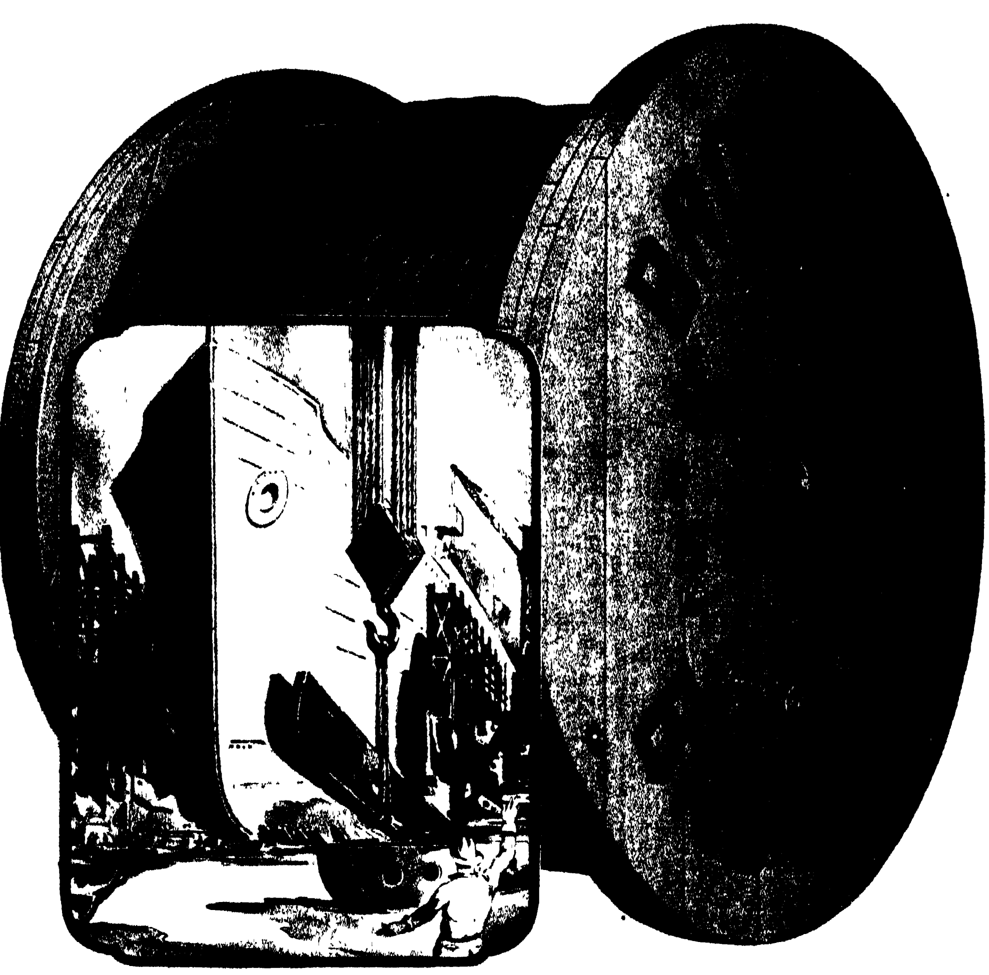
Prof. Felix Klemperer, the well known tuberculosis expert of Berlin, is willing to grant that the Gerson diet may have a favorable effect on tuberculosis of the skin, but he has not been impressed by the results in tuberculosis of the bones and joints, and he does not feel that the method is of importance in treating tuberculosis of the lungs. His view is also supported by that of Doctor Schwalm, who is in charge of one of the largest sanatoriums for the tuberculous in Berlin. Doctor Schwalm treated 20 patients with tuberculosis of the lungs by the use of this diet, and says that in not one of the 20 did he find any noticeable improvement in the condition, and also that the increases in weight were only such as were regularly seen in the sanatorium in patients on the usual diet. His final statement is: "We have not been able to discover that the Gerson diet is superior to the diet commonly used in German sanitariums, which also takes due account of the vitamins and includes plenty of milk, fruit, and vegetables."

Phosphorus Poisoning from Roach Paste

ONCE upon a time phosphorus poisoning was fairly frequent, due to the use of this substance in the manufacture of matches. Of late, such cases are seldom seen. In most instances they are due to taking a poison prepared for animals, by a child who has not understood the danger. Doctors McLean, MacDonald, and Sullivan have reported a case of a baby 18 months old who had formed the habit, not infrequent in babies, of picking up pieces of coal, matches, or other materials lying on the floor and putting them into its mouth.

The mother had spread a thick layer of roach paste on slices of bread and pieces of potato which had been put under the icebox in the kitchen. She noticed that two potato chips on which roach paste had been spread were missing, but did not associate their absence with the sudden symptoms that developed in the child. It had become drowsy and vomited. Its eyes became yellow. Its abdomen became distended, the wrists and ankles swelled and blood was passed both in the vomiting and in the excretions. Finally the excretions failed to flow. The baby died, and the postmortem examination indicated clearly that it had been poisoned by phosphorus. The typical changes in the liver, which had been practically destroyed through the formation of fat, were observed in this case.

The roach paste was found to contain 1.19 percent elementary phosphorus, and the container was not marked in any way to show the danger to human beings possible through its use.



You and Wire Rope

Although you may never travel by sea, ocean transportation is as necessary to your economic life as rail transportation. Yet the mammoth steel ship of today scarcely could be built without the great strength that is encompassed within the comparatively small diameter of wire rope.

Nor could the cargoes of these ocean liners be handled so quickly and economically without this flexible means of connecting power and load.

For over a half century this company has made wire rope exclusively. And in Yellow Strand Wire Rope, we believe we have attained the finest balance of strength, flexibility and resistance to wear ever developed in a rope for heavy duty. Long life and great economy are the natural result.

This company also makes all standard grades of wire rope.

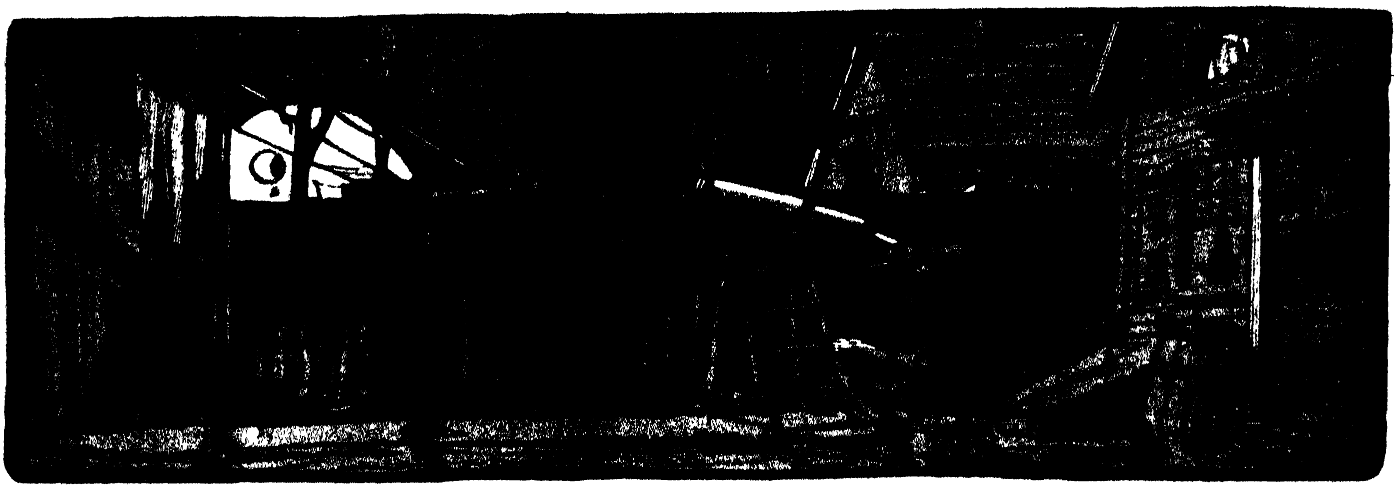
B. & B. Aerial Wire Rope Tramways are an economical means of transportation under many conditions. Investigate!

Broderick & Bascom Rope Company
St. Louis, Mo.

Eastern Office and Warehouse: 68 Washington Street, New York, N. Y.
Southern Warehouse: Houston, Texas
Western Offices. Seattle and Portland, Ore. *Factories:* St. Louis and Seattle

Manufacturers of nothing but wire rope for over half a century.

Yellow Strand
WIRE ROPE



The Amateur Astronomer

"NOW that my reflecting telescope is completed," writes M. S. Groh, 33½ Thorncliffe Avenue, Toronto, "I believe my experience will be of value to others. I commenced grinding the glass (which I obtained locally) more as an experiment than anything else. The grinding progressed favorably and the elbow grease employed shortly transformed the rough surfaces into a beautiful concave of about 50-inches focal length. The development of the accurate surfaces as the grinding advanced," continues Mr. Groh who, like hundreds of other readers of this journal, has been making an astronomical telescope from practical instructions in the SCIENTIFIC AMERICAN book, "Amateur Telescope Making," "was a feature of increasing interest, perhaps more fascinating than can be appreciated by anyone who has not experienced it. This is particularly true of the final polishing and parabolizing.

"Having completed the concave mirror in good shape it did not take long to mount it temporarily and, after a few crude attempts at seeing the moon, using a small looking glass for the diagonal, I commenced to believe that the job was worth finishing. So I made a prism of ordinary plate glass, to replace the rough diagonal mirror, bringing each face of this prism flat to within a wavelength of light. Two eyepieces were made from lenses secured from a local camera repair man and these when used with the telescope gave magnifications, respectively, of 80 and 130 diameters.

"The mounting I finally made is admittedly a bit light but is satisfactory when there is no breeze to shake the telescope. It has 3½-inch dividing circles which were indexed from a 72-tooth gearwheel. This gives me a fairly accurate line for every five degrees of declination and every 20 minutes of time in right ascension. The finder is an eight-inch length of half-inch tubing with the eye end stopped down to an eighth of an inch. No lenses are needed and it works well enough.

Mr. Scanlon's six-inch telescope

Mr. Groh and his reflecting telescope

"How much did the telescope cost? Well, all my spare time for six weeks, some gibes from my family (previous to completion; afterwards quite the reverse) and the exercise. The moon provides an interesting sight. So also do Jupiter with his four visible satellites, Venus, a number of double and other interesting types of stars, and a myriad of stars where to the naked eye there is blank nothing."

Mr. Groh requests the Telescope Editor to comment on the glass he used, that is, common plate glass. This is the kind used by all amateurs (and by professionals, too) on sizes up to 12 inches in diameter. Expensive optical glass would not serve the purpose better. For a six-inch mirror the glass disks should be three fourths of an inch thick. These disks may sometimes be secured locally, but they can be obtained from a special dealer, all put up in ready-to-begin-work form, with the correct kind of pitch and abrasives, for about ten dollars. Other parts, required several weeks later after the essential concave mirror is complete, may run the cost up to about twenty-five dollars, but the finished product should perform on a par with a 300-dollar instrument. A six-inch reflector equals a four-inch refractor in general performance.

F. L. SCARBOROUGH, 2105 Fourteenth Avenue North, Birmingham, Alabama, has made one of the telescopes of the type described by John M. Pierce, in "Amateur Telescope Making." Mr. Scarborough writes, "This simplified design was followed closely because the writer's knowledge of mountings, upon beginning the job, was negligible. There was only slight difficulty in any part of the work. My first attempt to make a polishing lap was a

Mr. Scarborough's tubeless telescope

failure, but on reference to 'Amateur Telescope Making' it was decided that the pitch of which the lap was made was too hard, so it was tempered slightly with turpentine and a softer lap prepared from it. Polishing with this lap was uneventful and the job was soon finished. (In the average case this takes about six hours—*Ed.*)

"Silvering by the Brashear process, as per instructions, was successful upon the first attempt. The directions for silvering were followed explicitly, using every precaution against contamination of the solutions.

"The results obtainable with this simple instrument are surprisingly good, amply repaying the slight expense, in this case about fifteen dollars which included the ready-prepared mirror outfit. The topography of the moon is strikingly clear and the effects due to changes in its phases are a wonderful sight. The planets are a delight. One view of Saturn with his rings and satellites, is generous compensation for the production of a telescope of this kind. These sights, together with others too numerous to mention, inspire one to a systematic study of science."

Mr. Scarborough's experience is typical of many others. It is perhaps difficult to believe that a raw beginner, with no more skill than is implied by the ability to do various handy jobs and with the possession of a little patience, can make an astronomical telescope that is more than a mere toy. But a six-inch mirror—the size best suited for the beginner—will magnify 100 diameters, and even at the large observatories it is seldom that more than 400 diameters magnification is used in studying planetary detail. That much magnification can be had with a 12-inch mirror which the amateur should be able to make after making first a six-inch mirror and preferably another intermediate size. Usually the beginner inclines in advance to regard the job of making the mirror as a task, but soon finds it is a real pleasure and wants to do more of it, so he makes a second and larger telescope; some have made several.

THE letterhead of Thomas F. Scanlon, 1405 East Street, N. S. Pittsburgh, Pennsylvania, gives evidence that he is a plumbing and heating contractor, but in his letter he says "I am a plumber, and I admit it." Mr. Scanlon's telescope is mounted almost entirely with various pipe fittings and plumber's accessories. This, of course, has been done before, though not so thoroughly, and this method has amply made good. These fittings are inexpensive and readily obtainable anywhere. The yoke that holds Mr. Scanlon's telescope tube was stated to be part of an old toilet tank and the retaining bands came from an old bricklayer's level. Their ends consist of brass sink bolts soldered on.

"The tube," writes Mr. Scanlon, "was made of 22-gage galvanized iron and cost one dollar fifty-six. The mirror is a six-inch and was completed during the evenings of two weeks. The eyepiece socket is part of an old wash-stand drain and some pieces of lead sink waste pipe, while the extension was made of nickeled tubing from an old wash-stand trap.

"The cell is a seven-inch perforated brass ring, a stock item in our business, having a raised seat on which the mirror rests. Three brass sink bolts were soldered radially to the circumference. These bolts fit into slots in the lower end of the tube

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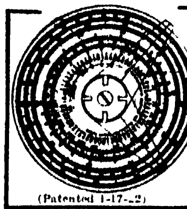

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and are held by wing nuts with washers. Similarly the mirror is held to the brass ring by three more sink bolts on which it rests. This perforated cell allows half an inch clear all around the mirror, permitting ventilation of the mirror at all times. (A fine idea, as it controls the temperature changes that may distort a mirror and affect its performance—*Ed.*)

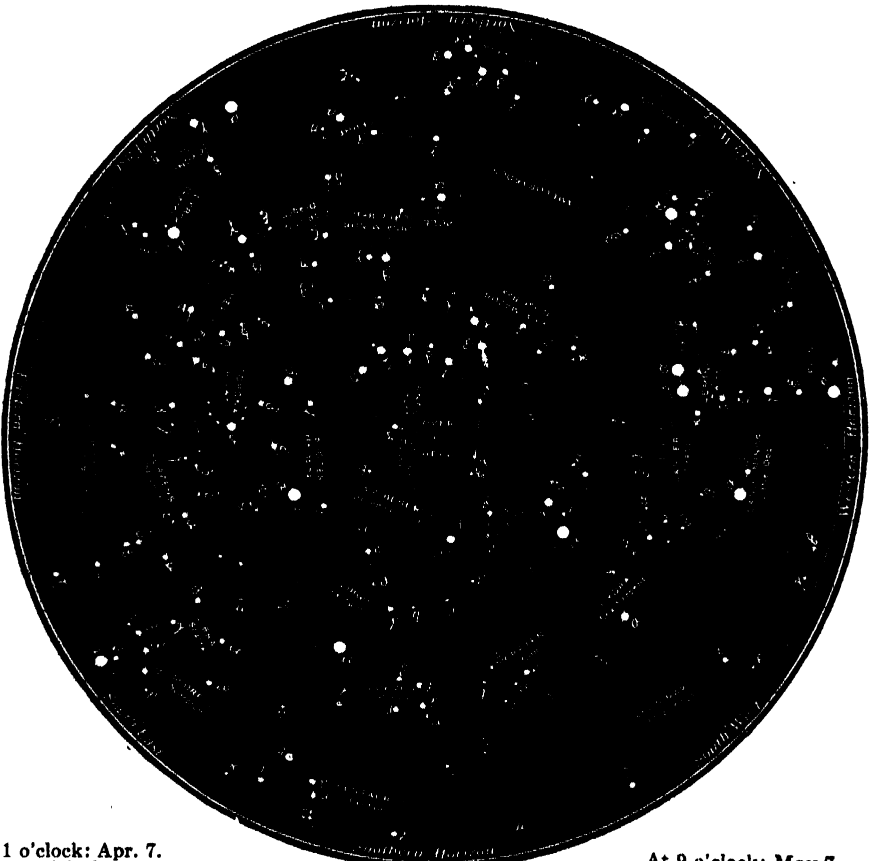
"Results?" Mr. Scanlon inquires. He answers his own question, "Yea, bo!"

THIS letter shows what a wide variety of picked-up second-hand dingbats an ingenious amateur can adapt to use in a home-made telescope. Most plumbers, in our own experience, are not half so resourceful, at least on jobs you get them to do for you. This, however, may be why Mr. Scanlon, who describes himself as a plain plumber, is really a plumbing and heating contractor. Readers having a nasty disposition may wonder whether a plumber, when he is doing this kind of work for himself, ever has to "go back for his tools." How does he figure up his time, and does he charge himself any profit on it? An anxious, breathless world would like to obtain these scientific data from a brother telescope maker who is presumably on the "inside."

All telescope makers are invited to send in photographs of their completed telescopes.—*A. G. I., Tel. Ed.*

The Heavens in April

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Apr. 7.
At 10½ o'clock: Apr. 14.
At 10 o'clock: Apr. 22.
At 9½ o'clock: April 30.
At 9 o'clock: May 7.
At 8½ o'clock: May 15.
At 8 o'clock: May 23.

The hours given are in Eastern Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on April 7, etc.

NIGHT SKY: APRIL AND MAY

MERCURY is in conjunction behind the sun on the first and is an evening star thereafter, on and about the 27th, when he is at his greatest elongation. He should be easily observable, as he does not set until 8:30 P.M. He is then in Taurus not far from the Pleiades and appears as bright as Capella or Procyon. Venus is an evening star and is steadily growing brighter. By the end of the month she stays in sight until 8:30 P.M. and dominates the evening sky. Mars rises about 4 A.M. in the middle of the month, but is not a prominent object in the sky. Jupiter is an evening star, setting about 10:30 P.M. in the middle of the month, and is very prominent in the evening sky. Saturn is in quadrature west of the sun on the 2nd and is observable in the morning. Uranus is in conjunction with the sun on the 1st and is unobservable. Neptune comes to the meridian a little before 9 P.M. in the middle of the month and is well placed.

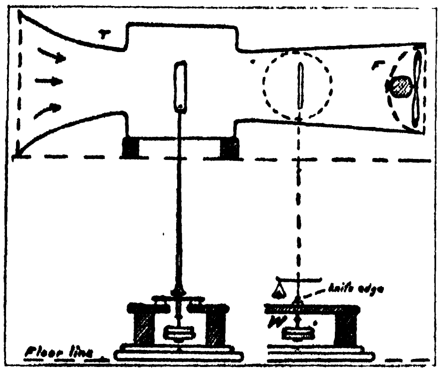
The conjunctions this month are with Jupiter on the 4th, Neptune on the 9th, Saturn on the 19th, Mars on the 25th, Uranus on the 26th, and Mercury and Venus close together on the 30th. The two planets are 2¼ degrees apart and the moon passes between them.

Learning to Use Our Wings

(Continued from page 312)

awake physics teacher can organize a course in practical aerodynamics, if he has at his disposal a physics or mechanics laboratory and a shop with carpenters' and mechanics' tools and supplies.

A small demonstration wind tunnel can be built so that it will fit on any good-sized lecture table. The cones can be made of thin wood strips, with wood barrel hoops on the outside. The exit cone is built to fit any electric fan available. A hinged door on one side of the channel, and a large sheet of window glass are desirable. A rough balance of the type shown in our diagram can be readily constructed. With a little ingenuity students can make measurements of lift and drag on wings and other surfaces. Airflow lines can be made visible by smoke-screens and by very fine silk threads.



A small wind tunnel, from "Elementary Laboratory Aerodynamics"

Mr. Jordan lists an imposing number of experiments which can be performed simply: measurement of lift and drag; tests of longitudinal stability; tests of directional stability, et cetera. His manual will be invaluable both to teachers and to students of the subject.

Passenger Rate Reduction

THE Transcontinental Air Transport-Maddux Air Lines have recently reduced their transcontinental passenger rates until they are no higher than those of rail and Pullman travel.

It had been previously believed in the industry that rates were not of as much importance as were the questions of safety and reliability. Yet in the week following the reduction in rates, the number of passengers increased in most surprising fashion and 222 revenue passengers were carried over some portions of the line. Forty-six of these were through-passengers, moving from coast to coast. These figures would appear to indicate that travelers have been waiting for more favorable rates.

Ice and Snow Landings

A FLYING boat can apparently take off from ice or snow. The ice was delaying tests of an Eastman flying boat, but it was found that the metal hull skidded along the ice so easily that it got off in about one half the time used in taking off from water. Subsequently the boat landed on the Grosse Ile Airport in about three feet of snow.

The event has some importance from the point of view of general adaptability of the flying boat.

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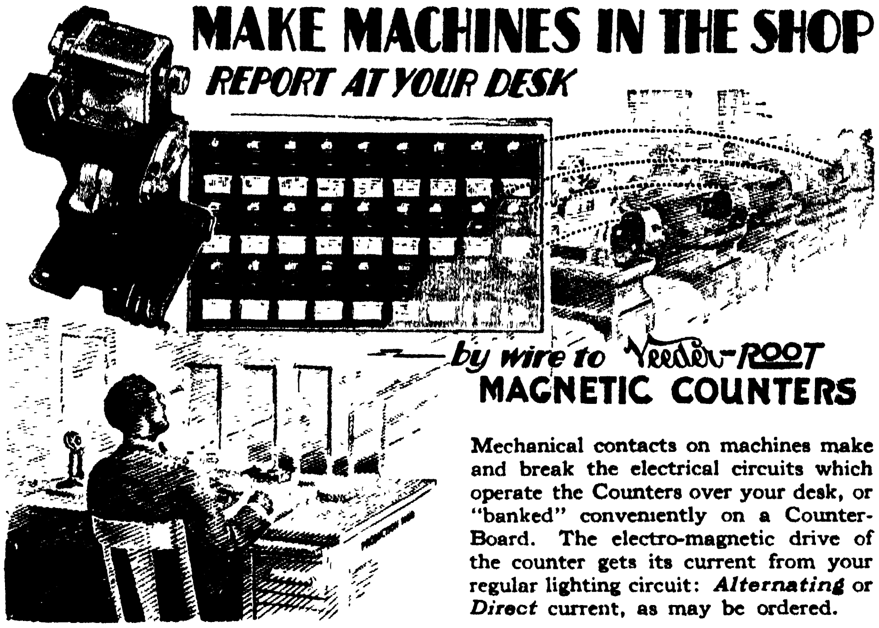

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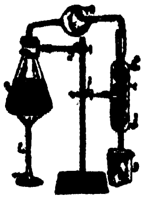

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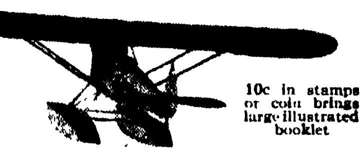

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Chemistry in Industry

(*Continued from page* 316)

The increasing applications of the centrifugal separator in industry is partially due to the improvement of the machine from its early state in which it developed a centrifugal force of only a few hundred times the force of gravity, to a model which produces a force 15,000 times that of gravity. E. M. James describes some of the applications of centrifugal separation in a recent issue of *Chemical Markets.*

In printing the color designs on leather, a paste or gum is used to hold the color and prevent it from running. The paste is mixed with the color and applied to the leather from copper rolls. It is extracted from certain species of shrubs, and in a crude form is likely to contain woody fibers. If these shreds of wood are not removed from the paste, the dye would show in streaks and the copper rolls might be blemished. Such a product would be difficult to filter, but is easily clarified with the centrifuge. The centrifuge discharges continuously a clarified paste, removing dirt, sand, and shreds of wood.

Centrifuges are used for the clarification of fuel oil used in the manufacture of glass bottles. Uncentrifuged oil contains a small percentage of tiny black particles. When the oil is burned such particles form incandescent "sparks" which fly into the glass, causing defects in the bottle. These particles are removed by a simple process of centrifuging.

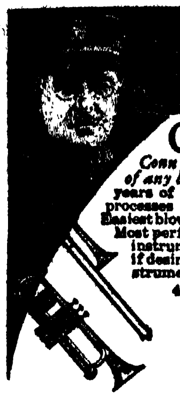
The clarification of baking enamels used by manufacturers of automobile bodies is being handled very successfully by centrifuges. The body parts are dipped, and any dust and other speck-forming particles would contaminate the paint. The used enamel from the dipping vat is reconditioned by the centrifuge, coarse foreign material being removed without disturbing the pigment. The process has invariably resulted in a reduced cost for a smooth, brilliant finish. In a typical plant but one half of the labor formerly required in rubbing is needed as the surface dries with a smooth finish.

The presence of small amounts of water and impurities greatly accelerates the deterioration of fatty oils. The result is the production of free fatty acids with consequent unpleasant flavor. This is often accompanied by undesirable bacterial action. The dehydration of butter oil is typical. Butter oil containing over 0.11 percent moisture does not keep well unless preserved. Butter oil separated from butter or cream oil and dehydrated with the centrifuge may be sealed in cans and kept indefinitely without deteriorating.

The clarification of lubricating oils for all types of machinery—Diesels, compressors, turbines, and machine tools—provides one of the most wide-spread and profitable uses of centrifuges.

Concrete Without Sand or Stone

LIGHT-WEIGHT concrete, made without sand or stone, is one of the latest achievements of chemists in the field of construction materials which has resulted in the production of a pre-cast slab for roof construction now on the market. The new slabs are said to weigh only about two thirds as much as similar slabs made from sand concrete. At the same time, the thermal conductivity is only about 87 percent that of sand concrete.



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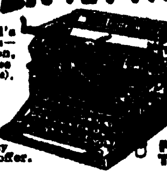

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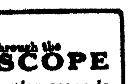

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As a result of the light weight of the new slab, which is said to have a strength equal to ordinary concrete, the manufacturers state that roof construction with this product ordinarily requires no heavier steel than is used with other materials.

It is said that ordinarily no additional insulation is required for a roof made of this material. The slabs are easily laid and require only a composition covering. Such a roof, it is claimed, is permanent, fireproof, and prevents condensation.

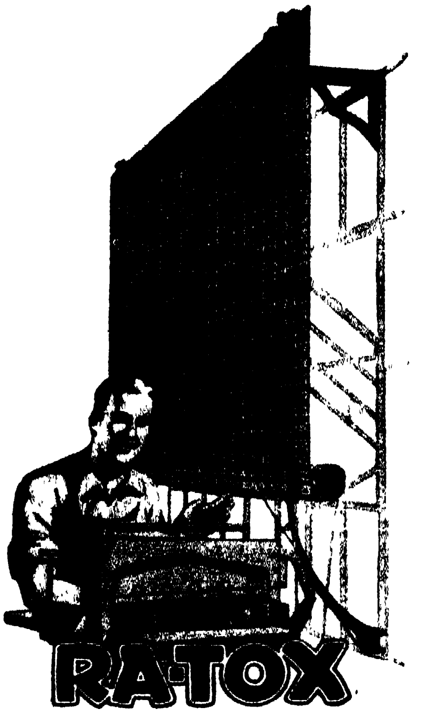
Minute Impurity Explains Riddle of Photographic Film

AMATEUR photographers, and professionals also for that matter, little realize the tremendous amount of involved chemical research that enables them to take a picture by merely pressing a button. The writer spent two years in the manufacture of photographic film, a sufficient experience to convince him that for pure cussedness and unexpected vagaries, there is nothing in chemistry to beat the behavior of photographic emulsions.

Photographic film consists of two layers, a thin translucent film containing a suspension of light-sensitive silver salts in gelatin, and a thicker transparent layer made either of cellulose nitrate or cellulose acetate. The light-sensitive layer is called the emulsion; the lower layer, the film base or support. It is in the making of the emulsion that the chemist finds his patience most sorely tried, partly because of minute variations in the quality of the ingredients and partly because the field is so fascinating that its exploration seems tediously slow. For example, one problem of practical as well as theoretical interest is the work done by Dr. S. E. Sheppard and his collaborators on the isolation of the sensitizing substances in photographic gelatin, described recently by G. E. Matthews in *Chemical Markets*.

For many years emulsion makers have known that certain gelatins were satisfactory and others were unsatisfactory for photographic use. Several years ago it was found that an extract could be prepared from a good gelatin which, on addition to a relatively inert gelatin, made it photographically active. An extensive investigation was then begun during which the entire process of gelatin manufacture was subjected to a thorough analysis. Hides, bones, cereal preparations, and many other substances were examined. Finally it was shown conclusively that a derivative of mustard oil, called allyl thiocarbamide, was the sensitizing substance. Its presence in minute concentrations of one part in 1,000,000 to one part in 300,000 was shown to be the cause of the suitability of certain gelatins for use in photographic emulsions.

During the emulsion making process, this substance is converted over by a series of reactions into silver sulfide which was shown to be present as small specks or nuclei and proved to be necessary in order that the grains could be developed.



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Our Point of View

Naval Conference Problems

(*Continued from page* 269)

Japan struck a discordant note by her insistence on a 10:7 instead of a 5:3 ratio in cruisers; according to the press, the Japanese delegation was reminded that any change in the 5:3 ratio would reopen the whole problem of fortified bases in the Far East as settled at the Washington Conference. As Japan is aware she was the real beneficiary of that treaty she probably will not press the point. With an army second only to the French, Japan will have difficulty in convincing the rest of the world that she is entitled to increase her naval force particularly at a time when she has difficulty in balancing her budget, and is already militarily predominant in the Far East.

ITALY has been tenaciously clinging to her claim for a parity with any other continental European State, meaning France. The informed claim that Italy would not build up to France even if she were accorded the right—that Mussolini's representatives are only engaged in a contest for prestige. France bitterly opposes any such recognition of Italy; and some say France is prepared to prevent any such agreement even if it involves breaking up the Conference.

Mr. Stimson has made a brave effort to find a satisfactory meeting ground for France and Italy by having the Conference formally recognize the right of any state to create any size army or navy it wishes, and then agree that for five or six years the five contracting powers will not exceed certain ratios in the various classes of ships. This is a constructive idea and will not only assist France and Italy to settle their present difficulties but will formally recognize that agreements reached in 1930 are not expected to bind in perpetuity the naval forces of five great and growing states, whose future naval needs can be only dimly discerned at present.

To date the most concrete proposal is that made by Mr. Stimson and apparently accepted by Great Britain; the part concerning cruisers contains a clause permitting sufficient adjustment between 6-inch and 8-inch gun classes to meet the needs of both states.

The following table indicates an approximate solution under the Stimson-MacDonald formula:

1			2			3		
UNITED STATES			GREAT BRITAIN			JAPAN		
No.	Cal. Guns	Displacement	No.	Cal., Guns	Displacement	No.	Cal., Guns	Displacement
10	6"	70,500	35	6"	193,000	21	5.5"	99,000
18	8"	180,000	15	8"	146,000	8	8"	68,000
11	6"	77,000				4	3"	40,000
39		327,500	50		339,000	33		207,000

Columns 1 and 2 show the probable result to United States and British cruisers if Mr. Stimson's plan is accepted. If Japan's contention for 70 percent instead of 60 percent of cruiser strength is granted, it would increase her cruiser tonnage to 238,000 tons which, if devoted entirely to

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8-inch-gun cruisers, could add 3 to her 12, giving her 15 8-inch-gun cruisers, a parity with Great Britain in that class. Australia and New Zealand are reported to object strenuously to a parity between Great Britain and Japan in this class of vessels, and it is no secret that our delegation is opposed to any increase of Japan's ratio.

The proposal to reduce capital ships to 15-15-9 by scrapping five British, three American, and one Japanese capital ships seems to meet general approval. This is a dangerous reduction for powers like the United States and Great Britain—whose fighting strength is practically limited to their fleets—for their armies are negligible compared to the conscript hosts of France, Japan, and Italy. The United States, in particular, would do well to resist the temptation to abolish the capital ship that still dominates the ocean routes and gives to a country possessing only naval power, some counterpoise to the land-powers of states with great armies.

France has good reasons for resisting the abolition of the submarine, which is the natural weapon of a weaker naval power; and it will not become us to oppose the French use of the submarine, for when our surface fleet was relatively weak we relied in large measure on the submarine as a balance. The improper use of submarines by one state during one war should not prevent the legitimate employment of an effective weapon of war. It is a curious fact that no one advocates the abolition of aircraft, yet everyone knows that, in the next war, more non-combatants will be killed by bombs from aircraft than by torpedoes from submarines.

THE American delegates have justified the country's faith in their abilities and so far have accurately reflected its desire for security and world accord. When the results of the Conference are ratified by the Senate it will remain for Congress to provide the necessary funds to carry out the modified program, and if the sum required to bring our navy up to parity seems large, we must remember that between 1922 and 1928, in modern cruisers alone, England laid down or appropriated for 162,000 tons, Japan 128,000 tons, while we constructed only 80,000 tons. We have already taken our cruiser holiday and we will soon be called upon to spend proportionately more than England or Japan, because our first plan of leading the naval powers to "cruiser disarmament by example" failed. It was an inspiring idea but the world was not then ready for disarmament by example.

Also, if our delegation obtains the right to construct one new battleship to balance the British *Hood*, we should improve the opportunity, for despite the newer weapons, the battleship is still the backbone of the fleet. In the years immediately following the World War, the question of national defense was considered from all viewpoints by the American Congress; many believed in an immense army raised by universal service, but finally in response to an overwhelming public opinion, the old system of a small, highly trained Regular Army, backed by the National Guard and Reserves was re-adopted. To shield the country while our miniature army expands, a fleet capable of meeting and defeating an enemy fleet on the high seas is necessary; and only to a fleet containing its full share of post-war battleships can such a tremendous responsibility be safely confided.

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Trademarks in Latin-America

WITH the growth of trade between the United States and the Latin-American countries, it has become necessary to consider carefully the question of obtaining foreign trademark registrations. These registrations must be secured to prevent the loss of trademarks in all countries where the laws for the acquisition of legal rights to trademarks are based on registrations.

Many trademarks which are the property of merchants in the United States have been lost abroad because our merchants have been educated under the registration laws of the United States, which make it necessary to use the trademark before filing the application for registration. In the Latin-American republics, and in some other countries, this is not the case, and when this United States practice is followed abroad unfortunate results often occur. In Latin-America, priority rights to a trademark are only acquired by filing a formal application for registration.

Inasmuch as the trademark must be registered in each country where the trademark is to be protected, an agreement was signed at a convention in 1910 which made it possible to register a trademark at a central office which would send abstracts of the mark to the registration offices of the countries which were members of the Convention. Unfortunately, many of the Latin American countries did not join this 1910 Convention, and many of the countries which did join subsequently withdrew.

To avoid objectionable provisions in the 1910 Convention, which were the reasons for these withdrawals, a new Convention was signed in 1923. This Convention has been ratified by the United States, Brazil, Cuba, Haiti, Paraguay, Dominican Republic, and Guatemala. Under the 1923 Convention, a trademark registered in the Patent Office at Washington may be registered at the Havana Convention Bureau by paying a registration fee. This registration in the Havana Bureau may be extended to the Latin-American countries which have ratified the Convention, by paying the customary fees.

Temperature Indicating Device Patent Sustained

ALTHOUGH Harrison H. Boyce was not the first to conceive of a trouble indicator for use in the daily run of an automobile, nor was he the first to conceive of the specific means which he describes in his patent, he was the first to apply those specific means to that particular purpose. In doing so, he performed an inventive act. This decision was made recently by the District Court for the Eastern District of New York in the case of Harrison H. Boyce and The Motometer Company, Inc., *versus* Taft-Buick Corporation.

The court ruled that the Boyce patent, Number 1206783, was not anticipated by the prior use of a thermometer as a guide to better engineering practice in the construction of the radiator or engine of the automobile. This patent was found to be valid and infringed.

However, the two claims in suit of the Boyce patent Number 1275654 were held to be so broadly drawn as to be anticipated by the Fowler patent Number 1159918. The patent granted to Fowler was for a thermometer on the dashboard of the automobile in view of the driver, whereas the Boyce patent shows a thermometer on the radiator. The Boyce application was filed prior to that of Fowler, but it was held that Fowler was the first to conceive the invention. These two claims therefore were held anticipated and invalid.

Trademark Denied for Laundry Service

A PRINT which identifies a laundry service is not registerable as a trademark, according to a recent decision of the Patent Office, because it does not "identify an article of manufacture." Dinks L. Parrish's Laundry Corporation had sought registry for an identification print. This application was denied by the examiner, whereupon the applicant appealed to the Commissioner of Patents. The decision of the examiner was sustained.

Wanted: More Co-operation to Develop and Market Inventions

IN a communication to the editor of the *New York Times*, which was published recently in that paper, Joseph J. O'Brien made a number of pertinent comments on the subject of "Patents and Progress." Discussing the proportion of profitable patents, Mr. O'Brien says, "About 25 percent of all patents are assigned before their issue, thus indicating that the ratio of patents regarded as having financial value is very large. This is a higher percentage of success than general business ventures can claim."

Pointing out that most instances in which a patentee fails to achieve success are due simply to a lack of merit in his invention, Mr. O'Brien shows also that no highly successful inventor can claim that he has never made any patent failures. Thomas A. Edison has a larger list of patent failures to his credit than any other man in the country, just as he has achieved more success than most inventors. Henry Ford, Mr. O'Brien points out, probably has the highest percentage of commercially successful patents to his credit, covering his own inventions. His patents are practically co-extensive with the devices or improvements he has embodied in his motor cars.

"All industrial progress rests on patented inventions, covered by either expired or active patents," Mr. O'Brien declares. "Only the investment trusts and banks listed on the Stock Exchange can fairly be said to be outside of the direct influence of patents. But even these base their investments in concerns partly or wholly controlled by patented inventions.

"It is difficult to get accurate information on the successes which inventors achieve. Within a brief period the press announced the death of three inventors who had become millionaires: Higgins of Brooklyn, who made his start with a patented ink bottle; Hartshorn, who gave us the spring shade roller, and Conrad Hubert, who invented the electric flash lamp and empowered the Coolidge board to dispose of 6,000,000 dollars. Oscar Hammerstein made 10,000,000 dollars from his patented cigar-making tables."

The *Times* contributor states also that it should be comprehended that practically every foundation invention in this country was the product of a so-called garret inventor. He believes that many of the practical discoveries of science are lost because accurate working knowledge of them is not properly diffused, and that engineering is usually more than a decade behind successful invention. As a means to effect closer co-operation between inventors, engineers, investors, and organized industry, Mr. O'Brien urges more study of the problems faced by the individual inventor in his struggle to carry on pioneer work. Attention also should be given to the need for a modernized system of co-operation between banking interests and inventors.

In conclusion, Mr. O'Brien says, "Much of the waste by inventors could be avoided by the application of better engineering knowledge and co-operation. Much of the loss due to delayed progress could be avoided by a policy of human understanding and beneficial co-operation with inventors. A large part of all patents filed should never be allowed to mature in formal grants, and would not if their applicants had fuller information. But many inventions now suppressed would be released for development if society would properly recognize its duty to inventors."

Edison's Goldenrod and Other Rubber Producing Plants

COMMENTING on a recent press announcement that Thomas A. Edison expects soon to supply rubber from the goldenrod plant, *Solidago virgaura*, at 16 cents a pound, *India Rubber World* presents the opinion of one of Mr. Edison's aides, who refutes the statement that any price estimate has been made on the rubber from this or other plants with which the great inventor is experimenting. Newspapers have led their readers to expect too much of Mr. Edison, apparently not realizing the difficulties which beset research in that direction.

"Mr. Edison said some time ago that he sought not so much a product to compete with commercial rubber as a material of which the nation might quickly avail itself in ample quantity were the rubber supply endangered by war or natural disaster," according to the editor of *India Rubber World*. "As to the latter, recent experience with the Mediterranean fruit fly in Florida reminds us of what can happen. A generation ago a blight so devastated the Far East coffee lands that their disheartened owners abandoned coffee and sought solace and found profit in rubber growing; and although history may not soon repeat itself, it is well to be vigilant. In brief, Mr. Edison's main and laudable object is one of national preparedness. It is possible that goldenrod, long a bane of hay-fever victims, may one day prove a boon to the country.

"While much is heard about one plant's possibilities, the potential usefuless of other promising rubber-yielding growths being intensively studied on American soil by government, industrial, and educational agencies is almost overlooked. Little is said about *Crytostegia grandiflora*, the milkweed varieties, *Asclepias subulata*, the rabbit bush, *Chrysothamnus nauseosus*, and many other plants that are known to possess rubber-producing possibilities.

"The outstanding American success is, of course, guayule, *Parthenium argentatum*, developed with great pains and expense from a wild southwestern shrub into a domesticated plant, grown commercially as far north as latitude 39, which can be cultivated and harvested as a stable crop. Its rubber content has been so increased and the extraction process so improved that the product can vie in price and quality with some of the best grades from foreign sources."

Solving Britain's Patent Problems

BRICKBATS by the dozen have been hurled recently at the British patent system by proponents of reforms of one kind or another. In England, as in this country, the chief "fault" of the Patent Office is that it is over-worked. However, it is reasonable to assume that an institution as old as the British patent system might profit by a housecleaning now and again.

Of the numerous abuses of the system, two of the most objectionable are the intertwined facts that there are too many worthless patents, many of them invalid, and that the cost of patent litigation is in effect discriminatory. *Nature*, England's leading scientific journal, editorially takes the stand advocated by Dr. Levinstein in a recent address before the Bristol section of the Society of Chemical Industry. He urged that the validity of patents be settled administratively before the patent is issued, or after the lapse of a given interval. Considering the expense involved in patent litigation before the High Court and the Lords of Appeal, exception is taken to the alternative proposed by the British Science Guild—that the Comptroller should be empowered to try infringement actions by consent of the parties. This course is held to offer no real solution, because either of the parties could insist on carrying the case to the High Court, perhaps with ruinous consequences to the opposing party.

"I am convinced," says Dr. Levinstein, "that the time to determine the state of common knowledge is before the grant of a patent, not years later: the place the Patent Office, not the Law Courts."

Upholding this view, *Nature* cites the fact that "every patent agent and every examiner in the Patent Office construes hundreds of specifications in the course of a year. The number of documents relating to his special industry which he construes, and his familiarity with the technical details of that industry, far exceed the equipment in these respects of a High Court judge, who may never have turned his attention to the subject until it is explained to him by expert witnesses. The issue is one which requires technical understanding rather than profound legal knowledge."

Nature shows also the handicap under which the Court sometimes labors in determining the status of "subject matter" in a patent case. "The problem is stated by asking whether a skilled workman, possessed of the knowledge which was common at the date of a given invention, could have devised the latter without exercising ingenuity. . . . The Court has to ascertain what might have been done a long time ago by a fictitious workman, in circumstances which never occurred, with the aid of an abstraction called 'common knowledge' the limits of which nobody can any longer remember, and subject to an undefined quantitative restriction which is erroneously apprehended as being qualitative."

As an example of the uncertain and conflicting decisions which result in such instances, *Nature* cites the case of Bonnard *vs* L.G.O.C. In this case, the three judges of the Appeal Court were just as unanimous in attributing ingenuity to the invention as the five Law Lords were in denying it. It is suggested that such issues might be settled more inexpensively by the toss of a coin, and that no great injustice would result if the decision were made before the sealing of the patent. More seriously, *Nature* contends that administrative settlement of the issue would be particularly suitable if present standards of "subject matter" were to be raised, and if inventions which did not reach the new standard could be made the subject of short-term patents. The Report of the British Science Guild (see page 460, November 1929 issue, SCIENTIFIC AMERICAN) recommended the inclusion of short-term patents in the British system.

Patents Recently Issued

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Pertaining to Aeronautics

AIRPLANE CONSTRUCTION—A wing construction composed of transversly disposed sets of strips spaced fore and aft, functioning as a supporting and lifting surface to allow of vertical as well as gliding descent, thereby eliminating the use of the usual ailerons. Patent 1743020. Thoralf Borgan.

APPARATUS TO FACILITATE AERONAVIGATION—Whereby a sighting means mounted for oscillation, and a recording device including a stylus, will supply the pilot with the necessary data to enable him to calculate his position when flying over a partially or wholly obscured area. Patent 1742355. Adirio O. Jessen.

PARACHUTE—Having a dilatable vent or aperture at its apex, so formed that when the air first enters the vent will be comparatively small to avoid the escape of air, assuming its proper shape as the cap becomes distended. Patent 1743951. Luigi Avorio.

Pertaining to Apparel

SUPPLEMENTARY OUTSOLE FOR BOOTS AND SHOES—Which may be readily applied by an unskilled person to worn boots or shoes to repair them for future use, or for preserving outsoles when worn in wet weather, or over rough roads. Patent 1744003. Edward Gallagher.

DETACHABLE SHOE HEEL—Which will permit the substitution of a new heel for one unduly worn or damaged, also the application of heels of various heights to the same shoes, for either walking or dress purposes. Patent 1743543. Manuel S. Gutierrez.

Chemical Processes

TITANIUM OXIDE AND PROCESS OF PRODUCING SAME—The process of producing pure dioxide of titanium from reactive titanium nitride TI_3N_2 which comprises heating the same in the presence of sulphuric acid and sodium nitrate, may be used as a basis for pigments, or starting material for other compounds. Patent 1742674 Foord von Bichowsky.

Designs

DESIGN FOR A DRESS—Patent 80279. Dorothy Long.

DESIGN FOR A COAT—Patent 80280. Dorothy Long.

DESIGN FOR LEATHER OR SIMILAR ARTICLES—Patent 80320. Frederick A. Kolb.

DESIGN FOR A WALL PLATE FOR ELECTRIC BUTTON—Patent 80335. Etta M. Squires.

DESIGN FOR A SPECTACLE FRAME—Patent 80311. Dorothy S. Helm.

DESIGN FOR A COAT—The inventor has been granted two patents, 80382 and 80383. Dorothy Long.

DESIGN FOR A COAT - Patent 80422. Dorothy Long.

Electrical Devices

TELEGRAPH TRANSMITTER—Which is simple in construction, having novel means for adjusting the weight for decreasing the friction during action, thus obviating the possibility of loose connections, and means whereby the various parts may be reversed to change the device from a right-hand to a left-hand operating transmitter. The inventor has been granted two patents, 1642296 and 1742297. John R. Youngblood.

SAFETY FUSE PLUG AND RECEPTACLE THEREFOR—Having terminal means in the form of keys projecting from the plug, and passing irregular openings, thus preventing the insertion of nondescript articles for bridging the contacts, and blowing out the main fuse of the installation. Patent 1743016. Emil de Bruijn.

FLASH LIGHT—Including within a single casing a plurality of batteries and illuminating bulbs with separate controls, whereby they may be separately energized for forward or rearward illumination on a bicycle or other vehicle. Patent 1743936. Ernest Segesser.

SPARK-PLUG TESTER—For testing plugs under substantially the same degree of compression they are subjected to in practice, whereby defects will be indicated which ordinarily would not show up when the plug is not under compression. Patent 1743881. Carman S. Cole.

DIAL CONTROL—Adapted for use in conjunction with radio condensers, indicating through what revolution the plates are moving at any time, and providing the direct reading of wave lengths or frequencies in conjunction with the revolution. Patent 1743927. Otto H. Luther.

ELECTRICAL HAIR TRIMMING AND SINGEING INSTRUMENT—Which includes a comb and an electrically heated singeing element, whereby the trimming of the hair by singeing the ends may be accomplished by moving the comb therethrough thus insuring a uniform finish without danger. Patent 1744525. Samuel O. Chase.

Of Interest to Farmers

HARVESTING MACHINE—A combined harvester and shocker wherein the cut stalks are formed into shocks which are deposited on the ground in an out-of-the-way position to permit the machine to operate on the next row without interference. Patent 1743013. Theodore A. Boor.

MILK STRAINER—Wherein the filtering elements are disposed in such manner that the liquid will impinge against the side walls thus preventing clogging and forcing therethrough material desired to be strained out, the parts may be readily cleansed. Patent 1742964. Hugh F. McNally.

INCUBATOR—Comprising a casing having fresh air openings, a water pan, electric heating apparatus, and revoluble egg cabinets which make absolutely certain a thorough circulation of heated and vaporized air through the entire cabinet. Patent 1742954. Avila C. Gillette.

PEANUT-THRASHING MACHINE—Which shreds the vines so that a loosening of the peanuts is obtained, a screen providing a rough separation, both the peanuts and the chaff being subjected to a final airblast for separation before delivery. Patent 1744906. Carl R. Livermon.

CULTIVATOR—Comprising a main beam, and an auxiliary beam pivotally secured thereto, adapted to cultivate two rows at a time, and novel means for giving a fine adjustment for positioning the shovels to suit the rows. Patent 1739508. Elbert H. and George W. Fincher.

Of General Interest

EARRING GUARD—For preventing the loss of valuable earrings, particularly the type attached to the ear lobe merely by clamping means instead of passing through a perforation in the lobe, the device is inconspicuous, being concealed behind the ear. Patent 1743006. Percival C. Prescott-Richardson.

METAL CLIP—Which may be used for numerous purposes, such as closing bags and the like, and also fastening together sheets of paper, cardboard, etc., the clip will serve effectively as a reusable fastener. Patent 1742989. John Fritz.

EGG BEATER—Having shanks removably secured to the body portion for permitting easy cleaning of the shanks and the beater without placing the body portion in water. The device may be readily packed in a small space. Patent 1742230. Porter K. Bushnell.

BEAM AND COLUMN CONNECTION—As used in structural steel work, whereby practically all the riveting may be done in the shop rather than on the field, completing of the connections requiring but a few rivets, whereby a great economy is effected. Patent 1744600. Albert J. Wilcox.

MOISTENING DEVICE—Comprising a liquid container and a rotable moistening member exposing freshly moistened portions of its periphery, for facilitating the handling and counting of money, checks and the like. Patent 1742548. Joseph H. Leal.

SPRING COVER—Particularly adapted for screwing on the threaded neck of a collapsible tube, the cover instantly returning to the mouth of the tube as soon as a lever is released, thus sealing the tube contents. Patent 1743293. George W. Toft.

ROAD SIGN—Particularly adapted for warning motorists of danger either from curves or other reasons, at night, the device will warn approaching drivers on both sides of the curve when hidden from one another's view. Patent 1743317. William A. Cannon and Howard J. Hall.

AWNING—Of the marquee type, including a top sheet or roof, a valance, and a collapsible frame, which permits the awning to be extended, the frame and canvas compactly folding against the building when desired. Patent 1744568. Earl Martin.

SAFETY RAZOR BLADE-HONING DEVICE—A small device including a casing especially designed for honing the blades of Auto-Strop Razors, the blade being honed without removal from the razor, thus preventing the possibility of cutting the hands. Patent 1744752. Ernest L. Crespo.

VISIBLE CARD INDEX—Comprising a guide and a card formed of two interconnected parts adapted to be inserted on the guide with one part beneath the guide and the other partly underlying and partly overlying the guide. Patent 1745262. Luigi Lombardini.

METHOD OF DECORATING WALLS—Whereby a multi-colored liquid film, and an absorbent plastic coating through which the liquid may penetrate, may be applied to wall-forming elements such as wall board or plaster board prior to its erection. Patent 1742332. Robert I. Vincent.

HOLDER FOR ACCOUNTING SYSTEMS—Particularly adapted for account-keeping of newspaper and periodical subscribers, wherein the accounts are rapidly available, yet effectively protected, always posted up-to-date, preventing errors and facilitating making reports to the main office. Patent 1742993. Carl A. Jettinger.

PILING FOR SUBAQUEOUS CONSTRUCTIONS—In the form of hollow metallic units having U-shaped members which will interlock and may be readily assembled to produce a rigid concrete-filled barrier possessing a maximum of strength from a minimum amount of material. Patent 1742947. Victor G. Brash.

SEW SLIDE FOR PORTABLE ELECTRIC SEWING MACHINES—An attachment which may be adjustably secured to the machine base, and will be perfectly level and flat with the sewing surface of the machine to which it may be connected. Patent 1742932. Robert W. Perry and Parker E. Abell.

TOOTHBRUSH—Having a removable head to permit of replacement, either end of the brush being secured nearest the handle, and having means for locking the head in a plurality of positions with respect to the handle. Patent 1742596. Edward R. Hoff.

VACUUM CLEANER—In which there is an intermittent suction produced by the admittance of air through a by-pass round the mouth of the nozzle, thus obviating danger of clogging, and the necessity of mechanism within the chamber itself. Patent 1742810. Richard T. Hosking.

HUMIDIFYING DEVICE—A relatively small moisture-retaining casing which may be placed within a receptacle to impart moisture to the air, and prevent the drying out of tobacco, cigars or other materials, without fear of undue moistening. Patent 1742962. Donald W. McCrosky.

Hardware and Tools

POCKETKNIFE—Wherein a proper spring action is provided for the respective blades without presenting the usual surface on the spring back, the blades co-acting with a spring means interiorly, and separate from the back. Patent 1743022. William Carman.

CUTTING TOOL—Wherein automatic power is employed for imparting the cutting impulses in the work, the tool being hand controlled, particularly adapted for cutting decayed tree trunks and forming cavities for the operations of tree surgery. Patent 1743988. George Van Yahres.

ROTARY CORE DRILL—Particularly of the type by which samples are formed, producing a core of uniform diameter, facilitating its removal from the barrel, eliminating disintegration, and insuring a core with the strata maintained in its original position. Patent 1742641. Arthur L. Armentrout.

MEASURING INSTRUMENT OR GAUGE—For engineers and mechanics, whereby shafting, piston rods and guides for locomotives, or other types of reciprocating engines may be accurately alined, the device may also be employed for determining the slope of roofing. Patent 1745252. Arthur B. Ginter.

NAIL HOLDER FOR SHINGLES—For asbestos and other artificial shingles, which will automatically move the nail to a correct position to be driven, enabling the workman to hold the shingle with one hand and hammer with the other. Patent 1745315. William J. Parker.

Heating and Lighting

OIL BURNER—Having a burner ring constructed to be raised above the fire pot thus effecting a saving of fuel also facilitating the removal for cleanings, and replacement of the ring should it become injured or require repair. Patent 1743021. William H. and Cecil E. Boston.

FORCED-DRAFT ATTACHMENT FOR FIRE BOXES—A blower and casing attachment for fire boxes of ordinary household furnaces, which causes an updraft through the fire, and directs air jets downwardly on the burning fuel, thus permitting the use of buckwheat coal. Patent 1743048. Frederick I. Sleaster.

Machines and Mechanical Devices

STONE-SAWING MACHINE—A cable saw which will cut at a comparatively increased speed, and is capable of being magnetized to pick up, and hold abrasive material such as steel shot, or metal filings, to augment the cutting. Patent 1743057. Albert E. Wienholz and Frederick Siefke.

BEATER MILL—In which a revolving beater forcibly acts upon heavier particles from a hydrating plant for lime, the heavier graded particles being automatically ejected in one direction, and the finer ejected by a separate path. Patent 1742511. William J. Kuntz.

CARD-DISPLAY MACHINE—Adapted to automatically raise the front card from a group of cards and hold the card a predetermined length of time, means being provided for two sources of lighting for illuminating non-transparent and transparent cards. Patent 1741228. William A. Garlick.

CONTENTS-DISCHARGING DEVICE FOR PUMP, DRILL, OR OTHER CYLINDERS—Susceptible of use as a general discharge support, but relating more particularly to supporting means for cylinders which may be conveniently mounted on the derrick floor, or suitable support convenient to an operator, in well drilling. Patent 17429[illegible]. Elgan S. Sloan.

Valve Mechanism for Flush Tanks—An automatically controlled inlet valve for controlling the flow of water to a flush tank, which is freely movable yet retained in closed position by the pressure of water in connection with a baffle. Patent 1744559. William S. Locke.

Apparatus for Treating Carbonaceous Material—For recovering hydrocarbon oil from oil shale, by the action of heat, for mechanically preventing the formation of clinkers in the lower combustion chamber, and at the same time reducing the spent shale to fine ash. Patent 1743394. William Rhoades.

Feeler Mechanism—Which is not subject to wear producing lost motion and loss of adjustment, is readily adapted to standard looms, and automatically provides for a minimum of waste on filling carriers when they are ejected from the shuttle. Patent 1744630. Ernest Hall.

Machine for Making Vermicelli and Similar Produce—In which the nutritive qualities, aroma and flavor will be preserved in either the solid or tubular forms, and providing means whereby the matrix may be readily removed for cleaning without stopping the machine. Patent 1744591. Fernando Taurel.

Dispensing and Vending Machine — Especially adapted for automobile fuels, whereby a single source of supply and a single discharge line may be used in connection with two measuring tanks enabling one operator to serve two customers at the same time. Patent 1744603. James W. Ames.

Flotation Process—An ore concentrating process, employing as a reagent finely ground sawdust from pine, mixed with comminuted ore before being delivered to the flotation machine for agitation, wherein the mineral portions are caused to adhere to the wood pulp. Patent 1743463. Joseph H. Lane.

Pump-Rod Swivel — To be interposed between the rigid pump rod of a deep well pump and its actuating cable, for eliminating friction due to the plunger tending to rotate in the barrel and part the rods. Patent 1745310. Theodor P. Novick.

Apparatus for Recovering Waste Air from an Air-Lift Pump—Adapted for attachment to the discharge outlet, affording facilities for separating the air from a mixture of air and water as it passes, so that the recovered air may be available for pressure fluid. Patent 1745085. Charles E. Denton.

Sheet Separator—For copy holders, which will hold a large number of sheets, will automatically discharge the copy and display individually the line which is being copied, so that that line alone will be visible. Patent 1744337. Lewis Sharp.

Paper-Cutting Machine—Particularly constructed for sand paper, the paper being continuously fed to the knife at right angles, the cutter quickly getting out of the way after the cutting, and more slowly resuming its position for the next operation. Patent 1744818. August W. Warsen.

Apparatus for Impregnating Stranded Elements—Such as rope, cords or the like, with means immersed in the impregnating substance for gripping the rope at a plurality of points to effect an opening or spreading of the strands, to permit of impregnation therebetween. Patent 1745285. Edwin J. Whiffen.

Vending Machine—A sanitary coin controlled mechanism by which single cigarettes may be fed into a delivery chute in a partially projecting position so that the vendee's hands do not contact with the delivery outlet. Patent 1745254. Irving Green.

Elevator - Guide - Rail - Lubricating Device—A lubricator of the capillary feed type which automatically supplies lubricant to elevator and counterweight guide rails in a uniform manner irrespective of the level of the lubricant in the reservoir. Patent 1743894. Albert Johnson.

Road-Resurfacing Device — A machine adapted to scrape the road sufficiently to remove the high portions, and smooth or plane the road immediately following the scraping, accomplishing the work ordinarily done by two machines. Patent 1744139. William J. Patton.

Dispensing Device—For completely storing a series of bottled liquids, in the arcuately shaped path of a cooling chamber, from which the bottles may be ejected one at a time, by means of a coin-controlled rod. Patent 1743917. John E. Henderson.

Means for Facilitating the Application to or Removal of the Knife from a Paper Cutting Machine—Which necessitates only drilling and threading of a pair of apertures, and the association therewith handle elements, whereby the knife blade may be safely handled during its application and removal. Patent 1743946. Horace S. Williams.

Machine for Facet Filing of Saw Teeth—So arranged that it files one edge of a saw tooth without touching the adjacent tooth, and immediately afterwards the other edge of the same tooth, without the saw being moved out of its position. Patent 1743898. Carl A. Janson.

Combined Beater and Vacuum Cleaner—In the form of a cylinder having blades movable through an opening in a casing for periodically beating the carpet while the section device withdraws the dirt agitated by the beater. Patent 1743954. Benjamin F. Blake.

Vending Machine—For vending single articles, such as apples, from individual compartments, a plurality of compartments being successively opened by a coin-controlled mechanism, and the empty compartments automatically replenished with an article. Patent 1743931. William A. Patton.

Routing and Grooving Machine—Which will, in one operation, produce grooves in wooden sticks and at the same time rout the ends of the grooves, the sticks being fed successively by mechanism which also automatically controls the operation. Patent 1744651. George R. Lessor.

Musical Devices

Transposing Keyboard—By means of which the instrument may be made to produce music in any key regardless of the key in which the composition is written, the keyboard itself being shifted. Patent 1743457. Henry Kinney.

Player Piano—Having mechanism for permitting musical instruments such as the piano, pipe organ, reed organ, etc., to be tuned and played in absolutely perfect intonation instead of in the tempered system now generally in use. Patent 1743458. Henry Kinney.

Imitation Keyboard—Which not only simulates in appearance a piano keyboard but simulates the action, the keys having inherent resiliency so that they may be depressed and return to normal position, the pupil silently accomplishing the proper action. Patent 1745225. Osbourne McConathy.

Railways and their Accessories

Railway Track Structure—Composed of complemented longitudinal sections assembled and joined with staggered section joints and having alining tread faces beveled inwardly in correspondence with the wheel level, thus prolonging the car wheel life, and its own life. Patent 1743598. Louis M. Coon.

Pertaining to Recreation

Aquatic Toy—Formed from an annular buoyant element, such as the inflated inner tube of an automobile tire, with the association of a bent wire frame, affording means for supporting a seat in the water. Patent 1743388. George B. Ely.

Pertaining to Vehicles

Direction Indicator — Especialty adapted for closed cars, whereby an arm is used for indicating stops, left-turn and right-turn, operated from the suction of the engine, and working practically in the same position as a driver signalling by hand. Patent 1741190. Anton Kessel.

Triple-Combination Lock for Steering Gears, Ignition and Transmission of Motor Vehicles—A thief-proof combination lock, having permutation disks, and operative simultaneously on the ignition system, steering gear and transmission of an automobile, airplane or tractor, in fact any mechansim using a steering column. Patent 1742963. James F. McGlynn.

Hydraulic Shock Absorber—Employing a plurality of fluid resisted pistons, allowing any desired rate of shock absorption to be attained, and at the same time reduces the loss of oil or other hydraulic medium to a minimum. Patent 1743959. Arthur St.C. Dunstan.

Windshield Warmer—For preventing ice and snow from adhering to the outside, and moisture collecting on the inside, by a flow of hot air from the engine directed onto the windshield, and means for regulating the hot air. Patent 1743395. Erwin A. Rinehart.

Starting and Light Switch—A simple and inexpensive switch for controlling starter motor, ignition and headlight circuits, from the instrument board of a motor vehicle, in a convenient manner, capable of installation on any of the known types of car. Patent 1743949. James G. Wortham.

Attachment for Automobiles and the Like—Especially adapted to be applied to the windows of an automobile for ventilating the car in cold weather without creating a draft, also having means for preventing frost or steam forming on the windows. Patent 1744154. Frank A. Bettag.

Removable Body for Hand Trucks—Whereby the body may be loaded at a point distant and later engaged by the hand truck for transportation, the body being formed with members interlocking with the truck. Patent 1744311. Frederick L. Jacobs.

Taxi Advertising Device—A device which can be conveniently located inside a taxicab, bus or other vehicle for displaying advertising matter, mechanical means between the internal combustion engine and the advertising assemblage providing an automatic change. Patent 1744705. Emmanuel Dobrowsky.

Automobile Bumper Bracket and Auxiliary Shock Absorber—Combining a bumper flexible enough to absorb up to substantially 3500 pounds, and heavy springs connecting the bumper with the chassis and designed to withstand a pressure up to substantially 15,000 pounds. Patent 1739930. Fred Ungar.

Carrier—For more or less fragile articles comprising a skeleton cage of circular outline with expansible gripping members forming the walls of the cage, adapted for detachable clamping engagement with the running board of an automobile. Patent 1740368. Earle F. Nusser.

Jacking and Traversing Attachment for Motor Vehicles—Whereby the front end of a vehicle may be lifted, and by means of a telescoping section and fifth wheel, swung into parking line under its own power, the attachment is adapted for vehicles of standard construction. Patent 1740385. August W. Althoff.

Collapsible Gocart—Having the appearance and shape of an ordinary suit case when folded, the wheels and other supporting members being readily movable to a point within the body so as to be completely enclosed thereby for transportation. Patent 1742137. Daniel J. de Grasse.

PATENTS

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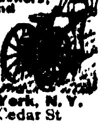

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AVIATION NUMBER

What Plane to Buy—Airplane Diesel Details

SCIENTIFIC AMERICAN

May 1930

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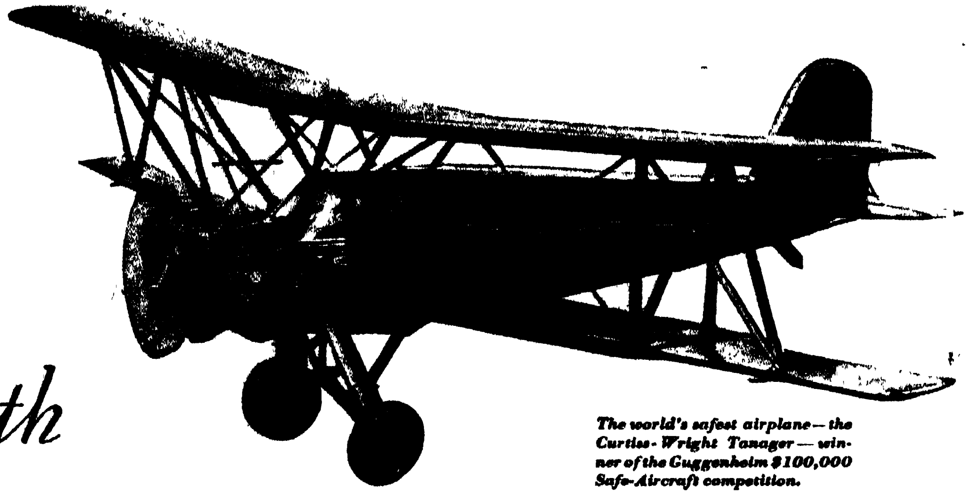

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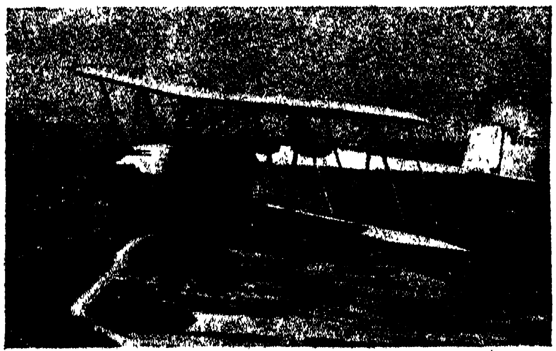

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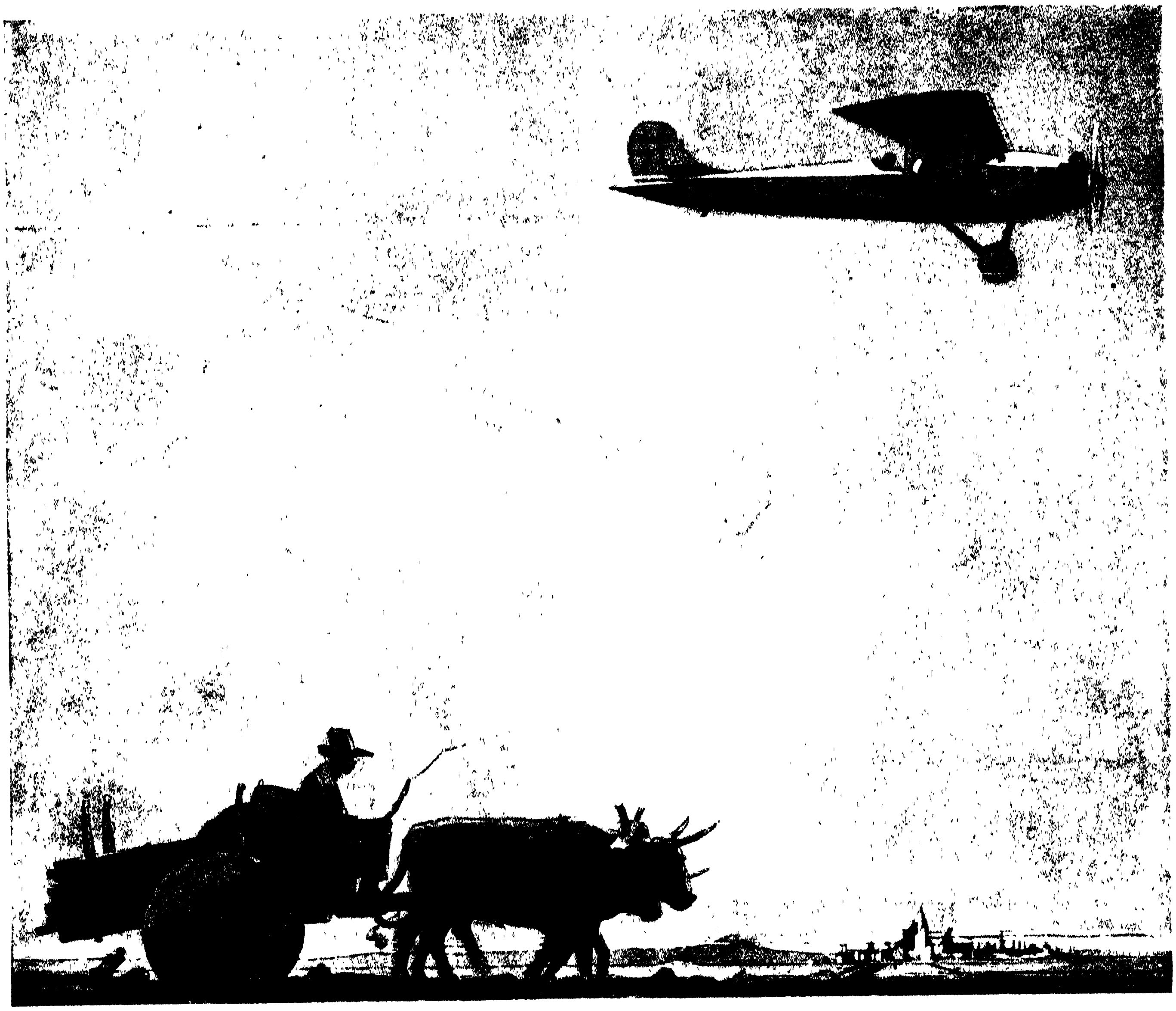

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COVER

Our cover illustration this month, done in oils by Howard V. Brown, is a conservatively idealistic conception of future travel. The fast ocean liner, at "The Cross-roads of the Air," salutes its still faster competitor, the dirigible, as it speeds majestically toward its destination. Several crossings of the Atlantic by lighter-than-air craft indicate that this picture may become, within a few years, a true reflection of a generally common method of ocean travel.

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By W. D. Puleston, Capt. U.S.N.

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It presents with blessed brevity and unusual clearness the essential parts of the campaign, accompanied with necessary comment to emphasize the significance of important events. While military students will find it accurate in the smallest details, general readers will be agreeably surprised at its easy style and non-technical language. Its appendix includes a bibliography of the campaign that will make a particular appeal to busy librarians. $3.00 postpaid

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By Milton Wright

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By Frederick Kuhne

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Looking Ahead *With the* Editor

Is There an Ether?

THE concept of an ether (of physics) to explain how a body can act "where it is not," e.g. the earth's gravitational action on the moon, dates from Newton. Why and what it is, many scientists have attempted to explain. Many people think the ether theory is no more, but in a coming article, Dr. Heyl says he believes the 20th Century has changed the form rather than the function of the ether, and that we'll always have it; he also reviews all the ramifications of the question.

Super Magnetism

THIRTY thousand amperes for one hundredth of a second! It seems impossible to switch on and off so much current in so little time but it is being done in England in the research on super magnetic fields. The development of the intricate and almost infinitely exact equipment for this work makes a story that is informative to scientists, professional and amateur, and significant to all. This article is now ready for release.

The Aluminum Age

A CHEMICAL curiosity at 545 dollars a pound 78 years ago, two dollars a pound in 1882, and now 24 cents a pound—with a production of 225,000,000 pounds in 1929 such is the history of aluminum. The universal use of this metal and its incomparable alloys lead some to predict that our era will later be called the "Aluminum Age." The interesting history and wide use of aluminum will be discussed in an early issue.

Aviation's Future

OUR present planes incorporate features that make for safe, dependable operation. What, then, does the future hold in store? Both the layman and the investor in aviation stocks are anxious to know. Predictions will, of course, be vague but the author of a coming article looks for improvements and spectacular experiments in the next few years, and the settling of the aviation industry on a stable business basis this year.

Interstate Rivalry on the Roads

AUTOMOBILES necessitated the construction of extensive highway systems. In the rush of building good roads, however, little thought was given to roadside beauty. Local pride is now changing this and roads are being beautified by the planting of trees and flowers. It is hoped, therefore, that our coming article on the subject will help to inspire a rivalry between states in this matter of making roads attractive.

Every Issue Fully Illustrated

¶ *Men are known by the magazines they read. What easier road to distinction could there be than reading the* SCIENTIFIC AMERICAN*—at four dollars a year?*

Among Our Contributors

Clarence M. Young

HAVING received his law degree at Yale, Mr. Young entered the Army Air Service when the United States declared war, and served 18 months overseas. He was shot down by anti-aircraft guns and taken prisoner. In 1926, he was appointed Chief of the Air Regulations Division of the Aeronautics Branch, Department of Commerce. He was promoted to the post of Director of Aeronautics and later was appointed by the President as Assistant Secretary of Commerce for Aeronautics. Mr. Young is a colonel in the Air Corps Reserve, an active pilot, and, when possible, flies his plane on official business.

W. D. Puleston

THERE are few men in the naval service today who have so complete a grasp of naval questions as Captain Puleston. A graduate of the Naval Academy, the Naval War College, and the Army War College, he served 17½ years at sea, also on the Naval War College staff, and published the authoritative study: "The Dardanelles Expedition."

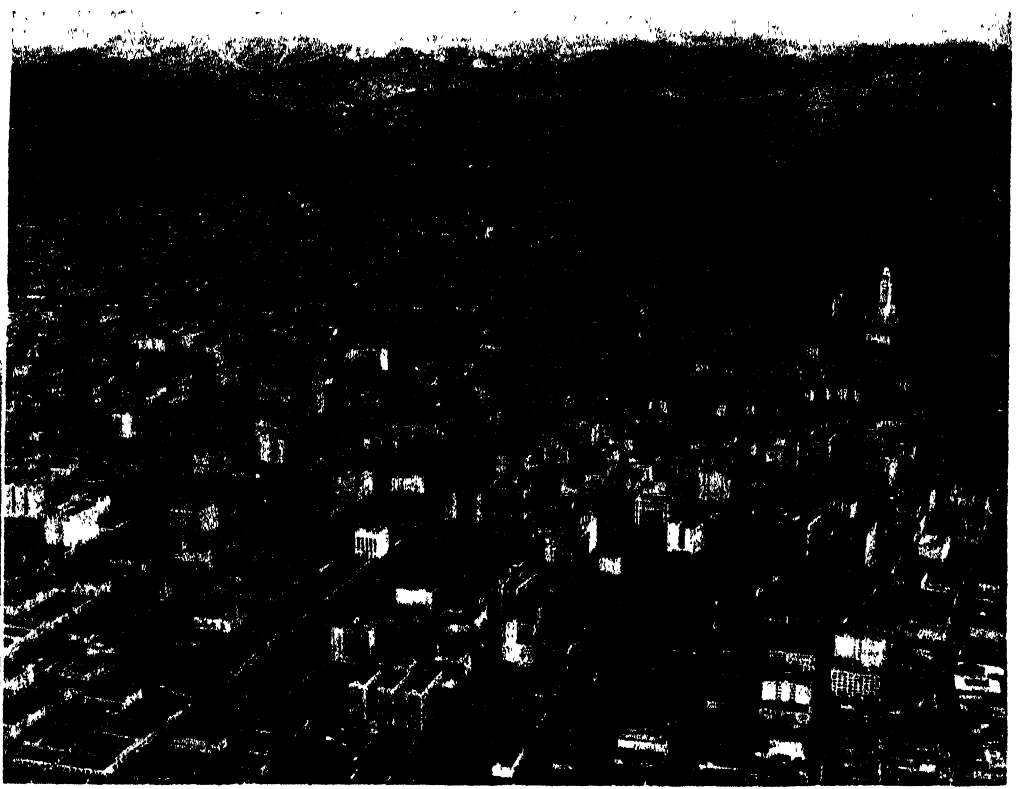
P. G. Johnson

UPON graduating from the University of Washington, Mr. Johnson entered the Boeing Airplane Company, then a small organization, as a draftsman. He advanced to the positions of Production Manager, Superintendent and Secretary, Vice President and General Manager, and finally to President and General Manager. Mr. Johnson is also a vice president of the United Aircraft and Transport Corporation of New York, a holding company which has 13 subsidiaries, including the Boeing aeronautical enterprises.

William H. Crew

LIKE the great physicist about whom he writes a splendid appreciation beginning on page 376, Dr. Crew is a graduate of the United States Naval Academy, later receiving his doctorate at Johns Hopkins. Since 1925, he has been Assistant Physicist at the Naval Research Laboratories.

Industrial - - -
LOS ANGELES COUNTY



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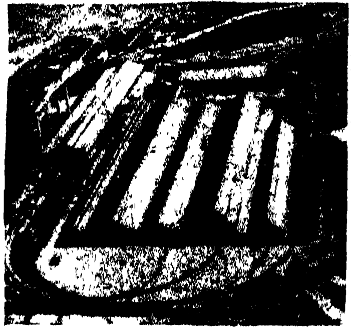
The Ford Factory at Los Angeles-Long Beach Harbor, nearly completed.



United States Steel Corporation enters Los Angeles County in 1929.

The Willard Storage Battery new factory to serve the Western States.

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—**With** *the only local supplies of petroleum and natural gas among cities of the coast,* abundant cheap water and electric power;

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—**With** a present *manufactured output exceeding a billion dollars* annually, and $35,000,000 invested in new factories and expansions last year, at lowest costs of building and maintenance;

—**With** a program of general development in 1930 of $400,000,000—

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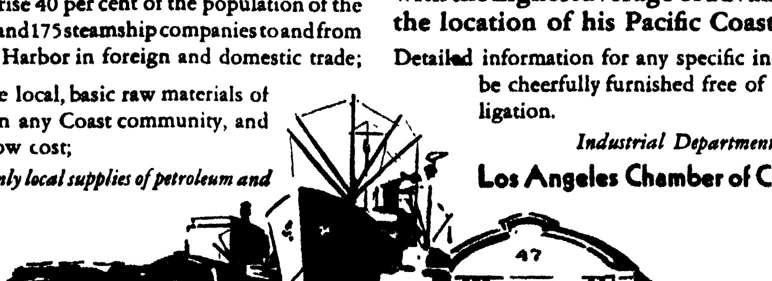
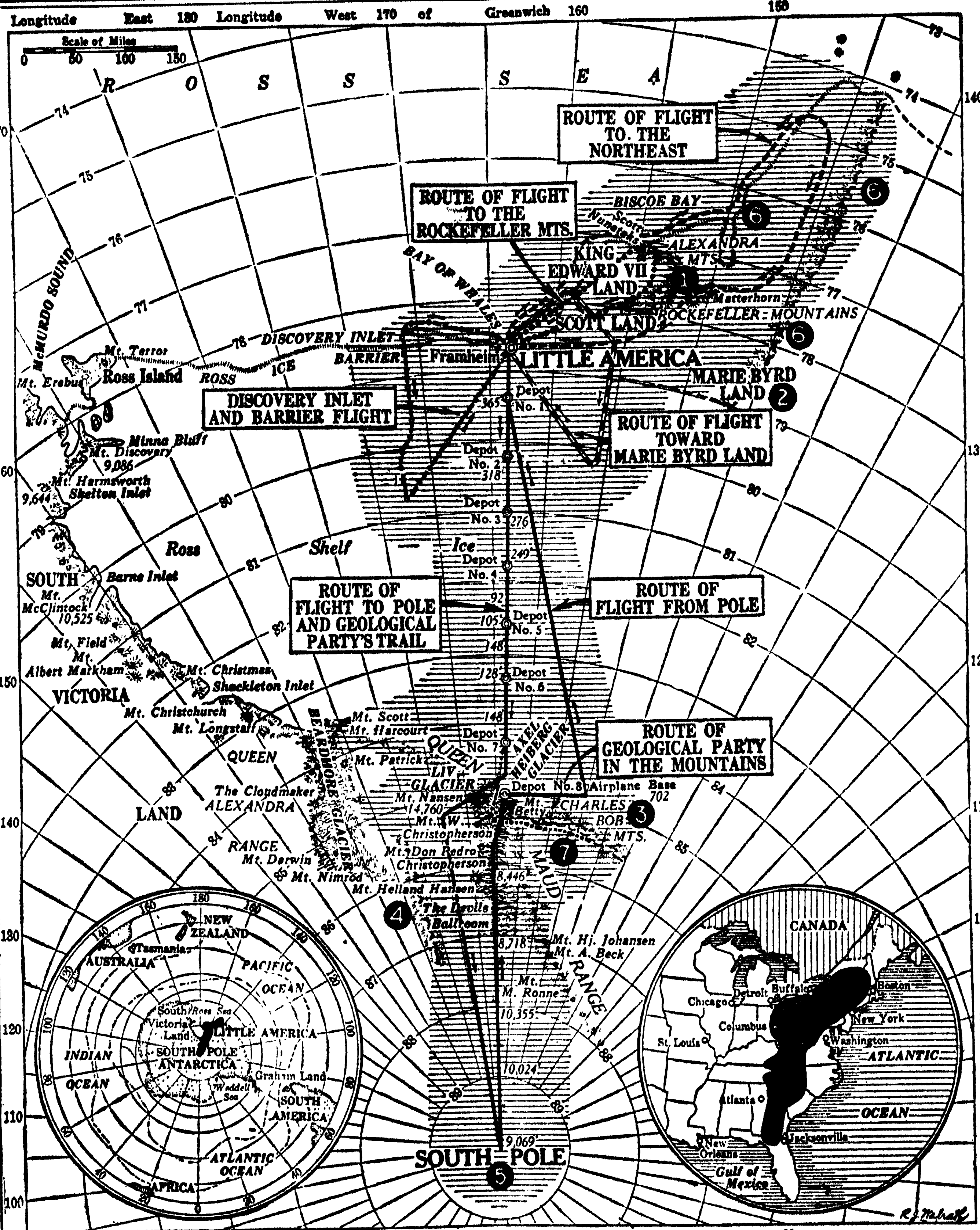
Los Angeles Chamber of Commerce



INDUSTRIAL LOS ANGELES COUNTY

Walter Franklin Prince

ELIMINATING entirely all the vast welter of unrelated "occult" hocus-pocus with which the name of genuine psychic research unfortunately has been linked by the muddled fraction of the public, Dr. Walter Franklin Prince. Research Officer of the Boston Society for Psychic Research, is a leader in the attempt to investigate without prejudice or preconception certain unexplained happenings which have the appearance of being psychic. Most men of science have chosen other fields—physics, chemistry and so on—for investigation because it is less difficult in these to obtain unequivocal findings, while valid research in psychic phenomena from first to last has been carried on among a host of besetting difficulties. Despite adverse judgments from many of the uncritical who have little or no idea of the rigorous discipline of the scientific method, or of what science means by a "proof," Dr. Prince has hewn to the line in his work. He has now been honored signally by election as President of the Society for Psychical Research (London) and will sail shortly to deliver his Presidential Address. The chair of the British organization previously has been occupied by many famous men—Sidgwick the sceptic, William James of Harvard, Crookes the physicist, Bergson, and others. For several years Dr. Prince has been a Corresponding Editor of this journal.



Courtesy The New York Times. Copyright

Admiral Byrd's Antarctic Expedition—Its Accomplishments

THE Byrd Expedition to Antarctica, recently concluded, explored and observed the shaded territory. Black inset at right shows the same area superimposed on a map of the United States. Besides flying to the South Pole, the Expedition discovered: Rockefeller Mountains, Marie Byrd Land, Charles Bob Mountains, a new mountain range on the polar flight, Barrier Inlet, and a vast coastal range. The geological party gathered much scientific data and erased Amundsen's supposed Carmen Land from the map of Antarctica.

All photographs courtesy Aeronautical Chamber of Commerce of America

WHERE THEORY ENDS AND PRACTICE BEGINS

What Is a Good Flying School?

The Department of Commerce Has Worked Out Regulations for Rating Aviation Schools and Has Approved Many

By CLARENCE M. YOUNG*

Assistant Secretary of Commerce for Aeronautics

PARENTS ask, "Where shall we send our boy for his aviation training? Claims of various schools are puzzling, and we know that the promises of some are misleading, even fraudulent. How, then, are we to decide?"

Colonel Young has answered these questions by a concise and direct explanation of what constitutes a high-rating air school. Information on those that have been rated by the Department of Commerce—at the request of the schools—is obtainable from the Department. The intelligent parent will "rate" others by a careful consideration of equipment, plan of operation, and honesty of purpose in comparison with the ideal school system described by Colonel Young.—*The Editor.*

WHEN, on February 28, 1929, the President approved the Bingham amendment to the Air Commerce Act of 1926, authorizing the Secretary of Commerce to provide for the examination and rating of civilian flying schools, upon their voluntary application, as to the adequacy of the course of instruction, the suitability and airworthiness of the equipment and the competency of the instructors, an important obstacle—the lack of a unified, government-approved system of flight training—was removed from the path of the development of civil aeronautics in the United States.

PRIOR to the approval of the Bingham amendment, Congress had authorized the Aeronautics Branch of the Department of Commerce to examine and license airplanes, pilots, and mechanics; examine and test engines and propellers; examine and approve airplanes as to airworthiness for manufacture under the Department's approved type certificate; to establish and chart airways, properly lighted and equipped with other aids to air navigation—in fact every provision had been made for the Government's assistance to the development of aeronautics and the protection of the public except in the case of the young man or woman who desired to become a pilot and make aeronautics a career or an avocation.

Up until the time authority was extended the Department of Commerce to examine and rate flying schools upon their own application, the Aeronautics Branch was deluged constantly with requests for information as to reliability, adequacy, and suitability of this and that commercial flying school. It was impossible for official replies to be given because of the absence of a known method under which some or all of the schools were operating. Consequently, the aspiring pilot was forced to choose for himself; sometimes he made a good choice and sometimes he did not.

The various schools and individuals giving courses in flying naturally adopted a method which, in their opinion, was the best; and often the course of one school embodied direct contrasts in theory and fact to the course of another, although both were intended to produce the same results. The beginner naturally was quite bewildered. Such a widespread condition could not help working a hardship on those upon whom we will rely in the future to contribute actively to the advancement and development of civil aeronautics in the United States.

ONCE the authority to examine flying schools was received, and facilities to handle this increased activity became available, we undertook the preparation of a supplement to the Air Commerce Regulations dealing

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*See "Among Our Contributors," page 341

HIS FIRST SOLO

Final instructions before the student takes off on his first solo: "Remember, don't get rattled"

entirely with the requirements to be met by the schools applying for an Approved School Certificate. This school supplement was prepared in co-operation with the schools themselves.

The first step in the preparation of the School Supplement to the Air Commerce Regulations, as it is known, was to classify the schools. Those giving instruction in flying are classed as flying schools, ground schools, or ground and flying schools. The approved flying schools are rated as follows: private pilot's flying school, limited commercial pilot's flying school, and transport pilot's flying school. Approved ground schools are rated as: private pilot's ground school, limited commercial pilot's ground school, and transport pilot's ground school, if operated in conjunction with an approved flying school.

Thus in the beginning the schools were classified according to their facilities and qualifications, so that no institution bearing the Department's approval would attempt to conduct a course in a subject for which it had not received a rating.

THE "suitability and airworthiness of the equipment" of a school applying for an approved certificate were defined in the regulations as follows:

All planes used for flight instruction in an approved school shall be planes licensed by the Department of Commerce for that purpose.

The minimum-sized field shall be one having at least 2000 feet of effective landing space in all directions, with clear approaches; or it shall have landing strips not less than 500 feet wide, permitting landing in at least eight directions at all times, the landing strips not to cross or converge at angles less than 40 degrees nor any one of the landing strips to be less than 2000 feet in effective length with clear approaches; or it shall have two landing strips, one aligned with the general direction of the prevailing wind, permitting at least four-way landing at all times and having clear approaches, the landing strips to be at least 500 feet wide and not less than 3000 feet in effective length and not to cross or converge at an angle of less than 60 degrees. The dimensions of the effective landing area and the effective lengths of the landing strips shall be increased at altitudes above 1000 feet, in accordance with accepted practice.

There shall be hangar space sufficient to house all airplanes used for instruction purposes and sufficient equipment and personnel to maintain such airplanes in an airworthy condition as required by the Air Commerce Regulations.

The total number of planes engaged in actual instruction from a given field shall not exceed 10 planes per hundred acres at any one time. The entire field should be available for take-offs and landings. Operations shall be limited solely to instruction during instruction periods where runways only are available.

Not more than 15 students shall be enrolled in flying courses for each airplane normally available for flying-instruction purposes.

Schools approved for ground instruction shall be equipped with one classroom for each hundred students enrolled, capable of seating 20 students. The classroom shall be furnished with suitable classroom equipment and facilities. Where the ground school is not under the management of, or connected with the flying school, it shall have at least three types of aviation motors in current use and three types of modern airplanes for demonstration and practical experience purposes.

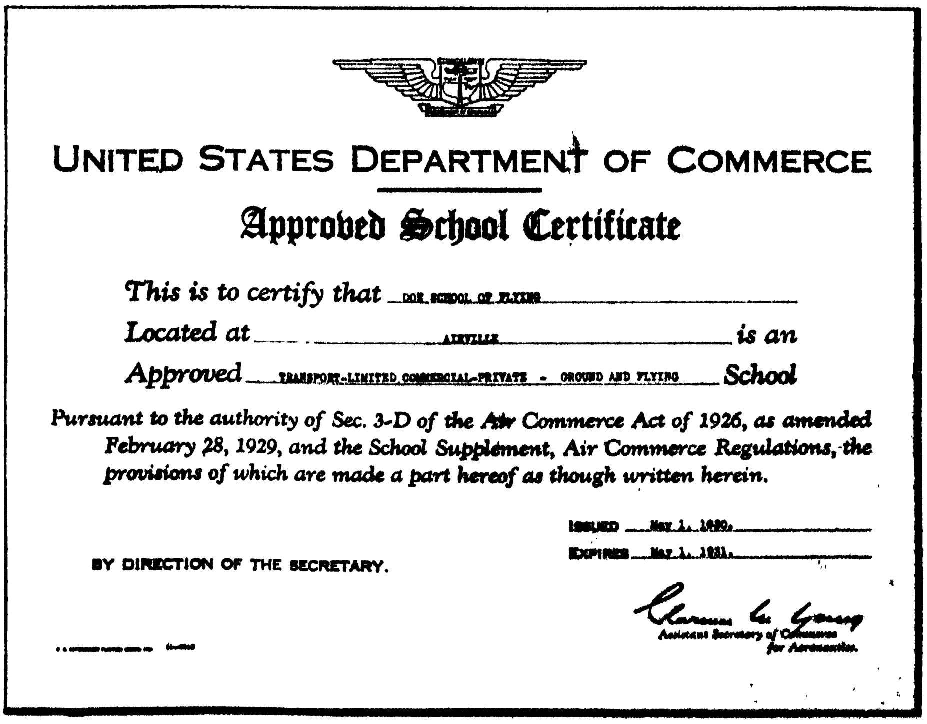
The "competency of the instructors" was set forth in the following provisions:

ALL flying instructors shall hold a rating from the Department of Commerce as flying instructors before being permitted to give instruction in approved schools.

A flying instructor's rating will run concurrently with his transport pilot's license and may be renewed semi-annually upon satisfactory evidence that he has served as a flying instructor in an approved school for not less than 50 hours in dual instruction during the preceding six months.

No flying instructor shall be allowed to exceed six hours of dual instruction in any one day, nor shall he give flying instruction more than six days per week. The school shall be responsible that the efficiency of the instructors is not impaired by continued dual instruction at or near the maximum daily allowable time.

All ground instructors, before being permitted to give instruction in approved ground schools, shall hold ratings from the Department of Com-



UNITED STATES DEPARTMENT OF COMMERCE

Approved School Certificate

This is to certify that DOE SCHOOL OF FLYING

Located at AIRVILLE *is an*

Approved TRANSPORT-LIMITED COMMERCIAL-PRIVATE - GROUND AND FLYING *School*

Pursuant to the authority of Sec. 3-D of the Air Commerce Act of 1926, as amended February 28, 1929, and the School Supplement, Air Commerce Regulations, the provisions of which are made a part hereof as though written herein.

ISSUED May 1, 1930.

EXPIRES May 1, 1931.

BY DIRECTION OF THE SECRETARY.

Clarence M. Young
Assistant Secretary of Commerce for Aeronautics.

INDEX TO A SCHOOL'S CHARACTER

Colonel Young prepared this sample Approved School Certificate to show how a school that has been rated by the Department of Commerce may be identified. It is nine by twelve inches merce as ground instructors. Ground instructors' ratings may be issued to those qualified to instruct in one or more ground-school subjects after successfully accomplishing examinations in such subjects prescribed by the Department of Commerce.

The minimum standards as to adequacy of the course of instruction are: When a student applies for license as a graduate of an approved school, such graduate may be privileged to count a portion of his dual and check time toward the solo-flying experience required for the Department of Commerce license, subject to the restrictions set forth in the regulations, provided he applies for license within 10 days from the date of graduation.

FLYING INSTRUCTOR AND STUDENT

Several planes, each with an instructor and a student, ready to take off on practice flights. In the air the instructor communicates with the student by means of the system shown

THE entire course, both ground and flight, shall be completed within a minimum length of time, the maximum allowable being four months for private school, six months for limited commercial school, and 18 months for transport school. There shall be a regularity of procedure of instruction, both ground and flight.

The school shall keep an adequate individual record of each student which shall include a chronological log of all instruction, both ground and flight, the entire record to be certified to by an authorized official of the school.

Upon completion of the course in each ground-school subject the student shall be given an examination on the subject matter covered, and all grades attained in all examinations shall be made a part of the student's individual record.

A complete outline of all flying-school and ground courses shall be submitted to and approved by the Department of Commerce. A monthly report shall be submitted to the Department of Commerce by the school showing the total number of students enrolled, with a chronological log of all instruction given each student in both flying and ground courses; the names of all graduates; the names of all students dropped from enrollment, with the reason therefor.

HOW THE PLANE IS BUILT

Future pilots may be seen here studying the parts and framing of an airplane. In foreground: welding a joint

The school shall maintain a standard of ground and flying instruction to assure that nine out of 10 graduates who apply for license satisfactorily pass the Department of Commerce tests; and shall maintain sufficient personnel and equipment to assure that the student will complete the course within the prescribed time limit. It shall maintain such standards that 66 2/3 percent of the students accepted for instruction are graduated from the course for which they have enrolled, exclusive of removal for due cause prior to completion of the course.

An approved school will be privileged to give refresher courses in both flight and ground subjects for the purpose of qualifying pilots who already have had the necessary total flying time for the grade of license for which they intend to apply. Such pilots shall be subject to the same guaranty to the Department of Commerce as has already been outlined. All dual instruction shall be around the airport area, and no cross-country shall be counted as dual. Every student must be given instruction in the recovery from stalls and spins prior to his first solo. In a private pilot's flying school, the school shall give the student a minimum of 18 hours total flying time, of which 10 hours shall be dual and eight hours solo. In a limited commercial pilot's flying school, the school shall give the student a minimum of 50 hours total flying time, of which not less than 15 hours nor more than 25 hours shall be dual and check time, and as such, be counted toward the solo-flying experience required for limited commercial license.

Each graduate of a private pilot's or limited commercial pilot's flying school shall have a minimum of two hours solo experience in flying each of two distinct types of planes other than those used for primary dual instruction, one of which shall be a cabin type. In a transport pilot's flying school, the school shall give the student a minimum of 200 hours total flying time, of which not less than 35 hours nor more than 50 hours shall be dual and check time and, as such, be counted toward the solo-flying experience required for transport pilot's license.

EACH graduate of a transport pilot's flying school shall have a minimum of 10 hours solo experience in flying each of two distinct types other than those used for primary dual instruction. He shall also have 10 hours solo on at least one type of cabin plane which shall be not less than a four-place type and which shall be loaded to normal capacity during these prescribed flights. He shall also have 10 hours solo experience in night flying.

The minimum required subjects and division of time in a private pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, carburetion, cooling, lubrication, and ignition), 10 hours; airplanes (including history of aviation,

PRACTICE

Part of the work of the ground school course in aviation consists in obtaining practical experience in the construction of a plane. Students are here shown assembling a monoplane

theory of flight, nomenclature, construction, rigging, maintenance, and repair), 10 hours.

Minimum required subjects and division of time in a limited commercial pilot's ground school are: Air Commerce Regulations, five hours; aviation engines (including principles of internal combustion, lubrication and cooling, carburetion, ignition, construction, various types, inspection, maintenance, and repair), 15 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 15 hours; aerial navigation and meteorology, 15 hours; five hours of each of the above required 15 hours on airplanes and on engines may be shop practice on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of the ground instructor.

THE minimum required subjects and division of time in a transport pilot's ground school are:

Air Commerce Regulations, five hours; engines (including principles of internal combustion, carburetion, ignition, lubrication, cooling, aviation types, construction, inspection, maintenance, and repair) 25 hours; airplanes (including history of aviation, theory of flight, nomenclature, aerodynamics, construction, rigging, various types, inspection, maintenance, and repair), 30 hours; meteorology, 15 hours; aircraft instruments, radio and its use in aeronautics, the parachute, its care and use, 10 hours; and aerial navigation, 15 hours. Ten hours of the above required 25 hours on engines and 10 hours on the above required 30 hours on airplanes may be shop practice, on the basis of three hours shop practice equivalent to one hour of classroom instruction. Shop practice shall be under the direct supervision of a properly licensed ground instructor.

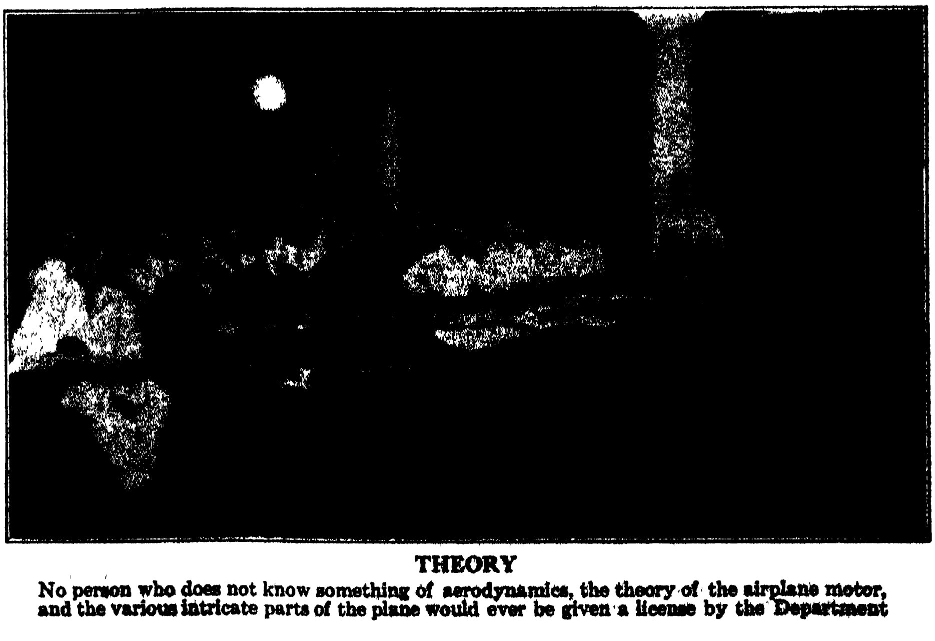
Any individual, partnership, or corporation engaged in giving instruction in flying either as a ground school or as a flying school or a combination of both, may apply for an Approved School Certificate upon a regular form provided by the Aeronautics Branch. This form, when properly filled out, enables us to determine whether or not the applicant has facilities sufficient to meet the standard of minimum requirements. If he has not, he is so informed.

THE inspector who rendered a favorable report on the application for an approved school by no means has finished his work with respect to that particular school. From time to time he will drop in unannounced on that and other institutions previously approved and make an inspection of the entire school to see that there have been no changes in the equipment, facilities, and conduct of the courses that will affect the standard of minimum requirements. Should he find a direct violation of the School Supplement of the Air Commerce Regulations, the evidence he produces would be grounds for suspension or revocation of the certificate.

Schools holding the Approved School Certificate are permitted to advertise their designations and ratings and thereby they obtain a decided advantage over competitors who have not applied for the Department's approval. The approved schools likewise are regarded by the general public as institutions worthy of patronage. For the first time since the Aeronautics Branch was established, we are in a position to answer inquiries as to adequate flying schools by forwarding the latest list of approved schools which speaks for itself and needs no interpretation or elaboration.

INADEQUATE instruction has resulted in a large number of accidents which otherwise would have been avoided had there been a definite and thorough standard of instruction followed. Our accident statistics show the human element in flying is credited with the majority of the causes of aircraft accidents, and one of the prime factors in the personnel question is proper and thorough instruction, as "errors of judgment" and "poor technique" lead in percentages of causes.

The approved schools are being looked to by the people of the country to graduate competent airmen and imbue them with sufficient knowledge of the subject to the end that they may always be able to protect themselves and others for whose lives they may be responsible, from accidents and mishaps that have resulted in the past from improper instruction and guidance. The Aeronautics Branch of the Department of Commerce, fully aware of its important obligation, is making every effort to see that the standard of minimum requirements in the approved schools is being followed constantly and consistently.



THEORY

No person who does not know something of aerodynamics, the theory of the airplane motor, and the various intricate parts of the plane would ever be given a license by the Department

OUR POINT OF VIEW

Air Rights

THERE have been many complaints against the flight of airplanes over private property and, in some sections, there has been agitation for state control of air routes to keep planes away from congested areas where a crash might endanger persons or their property or where their noise excites nervous people.

Even the most casual glance at flight regulations will bring the realization that here is a fertile legislative field that has scarcely been touched. Most cities have ordinances denying planes the right to fly below certain minimum altitudes and the Department of Commerce has made other stringent flight regulations but as yet there are altogether too few laws to exert a restraining influence on inconsiderate or foolhardy fliers. If laws are inadequate, however, it should be remembered that the industry is young and must feel its way carefully; regulatory measures will be taken as they become necessary.

The government recognizes air transportation and, by non-interference, implies that the flight of a plane over "posted land" does not constitute trespass. But the necessarily low altitude of take-off and landing may force, sooner or later, regulations as to the size of the airport or may authorize the acquisition of rights of way by the power of eminent domain. Complainants against the possible danger or annoyance of planes flying over privately owned land have at present only the weapon of city low-altitude ordinances, for the old theory that the property owner's rights extend to the skies has no basis in fact. When this theory was acceptable, no one had use for the air above building height. The rapidly growing air commerce of today, however, gives the question a different aspect.

Calendar Reform

THE Council and Executive Committee of the American Association for the Advancement of Science, speaking officially for the 18,000 members of that great association which includes the entire personnel of American science, has again gone on record as favoring calendar reform. At the last annual meeting the following action was taken:

"*Resolved*, that the American Association for the Advancement of Science approves of any alteration in the calendar that would adjust it to modern conditions for scientific work and that the Association would welcome in this connection co-operation with other bodies such as the committees of the League of Nations that are concerned with this subject, and,

WHEREAS, The Council is convinced that calendar simplification should be internationally adopted for the benefit not only of scientific work, but also of commerce and of the peoples of the earth in their daily lives, and likewise for the promotion of international and national understanding; therefore, be it

Resolved, That the Council advocates calendar simplification for international adoption as soon as may be practicable, and the calling of an international conference to report upon the best method, agreeable to all nations concerned, that will remove the serious defects of the present calendar; and favors a revision of the calendar such that the year will consist of 13 months of 28 days each and and extra day of non-week-day name, with an additional midyear leap day in leap years."

An editorial expression of opinion on the part of the SCIENTIFIC AMERICAN, regarding calendar reform, will be short: we favor it, though not necessarily in the above manner.

Under the Mediterranean

AN undersea railway tunnel, the conception of which, at first thought, seems to savor of the imagination of a Jules Verne, has been proposed by Spanish engineers and already preliminary steps have been taken looking to its ultimate construction. It would pass from Spain under the sea to the land of Spain's traditional enemies, the Moors. It would be 20 miles long—the world's longest—and 1500 feet below sea level at its deepest point.

Offhand, the economic value of this tremendous undertaking may be questioned. It may seem like more or less of a local affair, a connecting link between Spain and her north African interests. To realize its full significance, one must consider the vast commerce that is carried on between the African west coast and all of Europe. The products of the Belgian Congo, Liberia, Sierra Leone, the Gold Coast, the Ivory Coast, to say nothing of immense French and British possessions farther south, to the east, and closer to Europe on the Mediterranean—all with vast natural resources in minerals and products of tropical jungles and plantations—are rapidly assuming a very important place in the world's commodity markets. With a rail link directly through to Europe, it is certain that the future growth of western Africa would be phenomenal. And although the tunnel under the strait is as yet only in the projected stage, it is possible that within a decade or so a cargo of freight may be loaded on a train at Capetown and be discharged in Madrid, Paris, Brussels, or Berlin.

France and the Naval Conference

THE Conference has encountered only the expected obstacles but they offer more difficulty than at first appeared. In addition, the overthrow of Tardieu's cabinet provided an unexpected delay of three weeks and pointedly reminds the Conference of Mr. Macdonald's tenuous hold on the British Premiership. The domestic affairs of Great Britian, France, and even Japan are having a powerful, and may later have a decisive, influence on the outcome of the parley.

It is commonly reported in England that the Conservatives and Liberals will allow Mr. MacDonald to remain in office only long enough to convince independent British voters that the Labor Party's program will not solve the problem of British unemployment. In the last test vote in the House of Commons on one feature of this program, the Government was supported by a bare majority of eight. The necessary votes were furnished by Liberals who, anxious to prevent the premature fall of the Cabinet and the failure of MacDonald's naval disarmament program, supported domestic legislation they scarcely approved.

Tardieu's overthrow and rapid return have probably stiffened his attitude towards the Conference and it is now believed he will not reduce France's claims for more tonnage unless he is given some guarantee regarding the French position in the Mediterranean. Majority British opinion is against such guarantees and informed commentators point out that a similar agreement with France in 1907 guaranteeing French colonies and Atlantic Coasts from the German fleet, in exchange for protection of British interests in the Mediterranean by the French fleet, was the first of a series of steps that eventually involved Britain in the costly World War. This section of British opinion is firmly determined to entangle itself no further with Continental Europe. If this determination involves the failure of the Conference, they are prepared to accept the consequences and to resume their

(*Please turn to page* 402)

Revising Our Air and Our Water

A Piece of Research in Pure Science Provides an Unexpected By-product, Giving Atmospheric Oxygen an Isotope

By HENRY NORRIS RUSSELL, PH. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE radiations which the human eye can see have of course been thoroughly studied. The shorter ultra-violet waves have been photographed to the limit which the opacity of the earth's atmosphere sets inexorably. But the long waves of the infra-red until very recently have been detected only by the heating effects which they produce, (see upper illustration, opposite page) and this is a relatively insensitive method which no one would think of using for radiations which could be seen or photographed.

For years, therefore, astronomers have dreamed of plates which would be sensitive not only to red light but to the slower vibrations which the eye can not see. It has long been known that plates bathed in solutions of certain dyes become sensitive to the yellow and red, and these can now be bought anywhere. But to find dyes which would extend the sensitiveness still farther is a difficult thing to do and, moreover, a very expensive one requiring the work of many trained investigators. A few years ago the search seemed at a standstill, for all the money which was available to follow up a problem of purely abstract scientific interest had been exhausted. Relief came from an unexpected quarter.

ORDINARY blue sky reflects a great deal of the shorter waves of sunlight but very little of the long waves. So if a landscape photograph is taken through a screen which transmits only deep red and infra-red light the sky looks black on it. With the plates then available this demanded an exposure of minutes which, for a scientific curiosity, was all very well. Meanwhile, however, the moving picture producers had struggled with the problems presented by night scenes in their plays and succeeded by the use of powerful floodlights, which were naturally expensive. The infra-red landscapes showed just the combination of dark sky and brightly lighted foreground which they wanted but the exposures were far too long. An emulsion highly sensitive to the infra-red thus changed from the dream of the pure scientist to a requisite of a great industry. This justified the cost of further investigation and a new dye, "neocyanine," was discovered by the chemists of the Eastman Kodak Company, which makes it possible for the producers to photograph their "night scenes" in broad daylight.

The light which is most potent in producing these pictures is not really "invisible" but lies close to the limit of the visible spectrum at which the human eye, having already sunk to something like a thousandth part of its sensitiveness for the more familiar yellow and green rays, gives up the struggle to see further. The new plates are at their best here, and their range extends far out toward the longer waves, though with gradually decreasing sensitiveness. With the aid of these new neocyanine plates Dr. Harold D. Babcock at Mount Wilson Observatory photographed the solar spectrum to about 11,500 Angstrom units, some 2000 Angstrom units farther than the limit of previous knowledge, and has measured many hundreds of lines in the new region (see cut).

A REMARKABLE PHOTOGRAPH

Taken in total darkness by Babcock, by means of infra-red (heat) radiation from three common 600-watt electric heaters under-excited so that they were invisible even to the dark-adapted eye. Exposure 48 hours with F/2 lens. The "secret" is the new neocyanine sensitized plate

It was by no means easy work. The chief trouble came from scattered light. Even in the best spectroscope a small amount of light is reflected from the surfaces of the lenses and the prisms (or the grating) and, after various vicissitudes, is distributed broadcast in the field of view. In ordinary work this produces a faintly luminous background which does no harm at all. But in the present case the plates were hundreds of times as sensitive to the ordinary red rays and even to those just beyond the limit of the eye as they were to the long waves which were to be studied, and if indeed even a very small part of the former rays were scattered the plates became fogged. It was necessary to find some screen to place in the path of the rays just outside the spectroscope which would cut out entirely the red and near infra-red while transmitting the longer waves. After many tribulations this problem was solved and step by step a new region half as long as the visible spectrum was added to the field of precise astrophysical knowledge.

After the hundreds of lines have been accurately measured, new problems arise. Some of them are produced in the absorption of light by the hot gases of the sun's atmosphere, others by the cold gases of the earth's. To distinguish between these an old but very pretty device may be employed. Photograph on the same plate in parallel strips the spectrum of the eastern and western limbs of the sun. The first is coming toward us, the second receding, and in consequence all the solar lines are slightly shifted toward the violet and the red, respectively. The lines produced in the earth's atmosphere are of course unaffected and may thus be distinguished with certainty.

THE next task is to find what substances produce the lines and this will take some time, for the spectra of even the more familiar elements have not yet been photographed in this new region. A few strong lines which had been detected in the laboratory by means of heat measuring devices already have been identified.

Nearer the visible spectrum where laboratory comparisons were available many interesting things have already been found. For example, a group of lines belonging to carbon (see spectrogram) and two fainter lines of sulfur have been identified beyond the limit of the visible red. The first of these familiar elements previously had been detected in the sun only by means of its compounds (though some very faint lines of the element itself have since been recognized in the green). As for sulfur, the new plates provide the only proof we have of its presence in the sun.

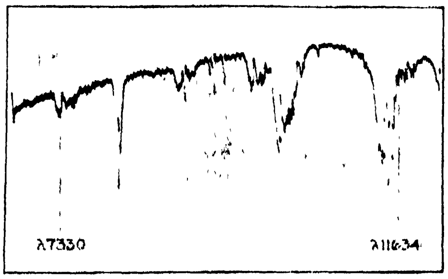
But discoveries have not been confined to the sun. The most remarkable one has been made on our earth, or rather in its atmosphere. It is of interest primarily to the chemist and yet it has been made by the very methods which the astronomer employs in analyzing the sun. In the red end of the solar spectrum there are two strong bands composed of closely grouped pairs of lines which were recognized in the very dawn of spectroscopy by Fraunhofer, who gave them the letters A and B. These are due to oxygen—not to hot atoms of the element in the sun's atmosphere but to cold molecules in the earth's. This has long been known but it is only within the last few years that the theory of such banded spectra has gone far enough to let us understand what the molecules were doing.

A molecule composed of two atoms can act in a much more complicated way than a single atom—not only can an electron "jump" from one state to another but the two atoms may vibrate, changing their distance from one another, and the molecule as a whole may rotate. Both the vibration and rotation are quantized and may change from one state to another by jumps, and each set of jumps gives a different line in the spectrum. Different changes in the vibratory motion of the oxygen atoms, for example, give rise to the A band in the deep red, the weaker B band in the red, and the fainter bands in the orange and green, while different changes in the rotation of the molecules give the separate lines in each of the bands. This sounds complicated, but so are the spectra! The complications, however, open the way to find things that would otherwise be quite out of reach.

It is a familiar enough fact nowaday that many—indeed most—of the chemical elements are really mixtures of different kinds of atoms called isotopes. The isotopes of any given element are exactly alike in their chemical properties but different in weight. Thus, for example, there are two kinds of chlorine of atomic weights 35 and 37, the observed value 35.46 being an average for the two which are present in unequal proportions.

Aston, with his ingenious "mass-spectrograph," has with great skill identified the isotopes of a great number of elements and determined their atomic wights. Is there any perceptible difference between the spectra of two isotopic atoms—for example, the two kinds of chlorine? When we have to deal with the spectra of free atoms the differences are of extraordinary minuteness—just perceptible in one or two cases with the most powerful apparatus, but practically negligible. This means that the energy involved in jumps of the electrons within an atom depends almost wholly on their own arrangement and hardly at all on the mass of the heavy nucleus at the atom's center.

But when two atoms are united in a molecule things are different. The energy of vibration of the two about their average distance, or the energy of the rotation of the molecule, does depend to a considerable degree upon the actual weights of the vibrating or rotating particles, and there are corresponding differences in the spectrum. For example, there are two kinds of atoms of boron, of atomic weights 10 and 11. When combined with oxygen (to form the incomplete molecule BO) each of these isotopes gives a complete band spectrum. The two sets of bands are just alike in structure but shifted in position sometimes by a good many Angstrom units, so that they may easily be separated on the photographs. In this way the existence of a number of Aston's isotopes has been confirmed independently.



OLD TYPE OF RECORD

Not a spectrogram but a bologram of a portion of the infra-red solar spectrum, made with a bolometer, by Dr. C. G. Abbot. The varying heat as different parts of the spectrum were passed changed the resistance of platinum wires, actuated a galvanometer, and cast a beam of light on a laterally moving photographic plate. The limit of Rowland's former photographic study of the spectrum, also the new limit with neocyanine, are indicated at wavelengths 7330 and 11634 A. U.

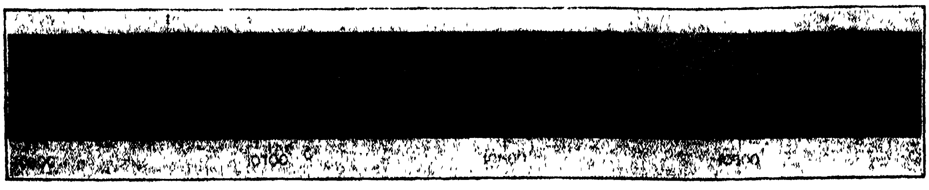
Now in the vicinity of the strong lines of the A band of oxygen there are some much fainter lines also produced in the earth's atmosphere. Two young investigators at the University of California, Giauque and Johnston, using Babcock's measures, have found that these lines are exactly where the bands due to an isotope of oxygen ought to be. The ordinary atom of oxygen has a weight of 16 standard units, and the common oxygen molecule O_2 is composed of two of these. Molecules composed of one oxygen atom of weight 16 and one of weight 17 account for the new bands.

A new kind of atom in the air which we breathe has therefore been discovered by spectroscopic observation of the sun. Moreover, the spectra showed how much of the new kind of oxygen was there. By comparing the strength of the lines of the new molecule produced when light traverses the whole thickness of the atmosphere, with those of the familiar kind produced by layers of air a few meters thick, Babcock found that only 1/1200 as great a thickness of air was required to match the lines. Hence only one oxygen atom in 1200 is of the heavier sort. This explains the otherwise disconcerting fact that Aston's very careful work did not detect the new isotopes, for according to his own estimate his apparatus could not have shown it up if it had been less than 1/1000 as abundant as the principal isotope.

It is probable that the spectroscopic method may detect other isotopic atoms present in too small amounts to be found otherwise. If there are two kinds of oxygen there must also be two kinds of water, ordinary H_2O with an atom of O_{16} and a rarer kind with O_{17}. Is there hope of detecting the latter among the numerous water-vapor lines which are produced in the earth's atmosphere? Some day perhaps, but a deal of work remains.

Water is an amazingly complicated thing, even in its simplest form of vapor. Its molecule contains three atoms and such a system still defies the best efforts of theory. All three atoms attract one another and they may all change their mutual distances when they vibrate, so that a great many different modes of vibration are possible. And when such a molecule rotates it will not in general rotate smoothly and uniformly but will wobble in accordance with definite mathematical laws and in a very complex fashion. We should therefore expect the spectrum of water vapor to be complicated and it is exceedingly intricate—full of bands extending from the visible spectrum up to wavelengths more than 100 times as great. The recent photographs show that the infra-red bands are composed of a multitude of lines too closely packed to be separable except by the photographic method.

To work out the complicated changes in the molecule which produce these lines will try the mettle of the best investigators, and it may be a long time before all the problems which the new photographs of the spectrum offer have been solved.—*S. S. Leopolis, Gulf of Corinth, Dec. 9, 1929.*



INFRA-RED SPECTROGRAM MADE PHOTOGRAPHICALLY

The range of radiation included here—half as long as the visible spectrum—would be totally invisible to the eye and would not affect an ordinary plate. Other spectrograms have been measured as far into the infra-red as 11684 A. U. Line in margin near 10700 is almost certainly due to atomic carbon in the solar atmosphere. Spectogram kindly furnished by Babcock of Mount Wilson, the astronomer to whom Dr. Russell refers in the text

When You Buy Your Plane

What Details of Construction, Features of Operation, and Factors of Safety to Consider

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

THE uninformed non-flyer who is in the market for the purchase of an airplane is immediately astounded with the number of models and types from which he may choose. As in the automobile industry, each particular type has its adherents.

The prospective purchaser finds that every professional aviator is a potential salesman for some airplane company. His arguments are generally shaded by a possible commission. True, however, if he does not believe in the type of plane he himself flies and sells, no one else could be expected to have any confidence in the ship.

As a matter of fact, each particular type of plane probably has one or more good features. All the best points can not be incorporated in any one ship. Every plane is a compromise. For instance, if a high top speed is desired, a high landing speed necessarily results. But, it happens that a low landing speed is also desirable. Both cannot be had in the same plane. The designer gets to work. He adopts a safe landing speed and must accept the maximum speed which is then attainable.

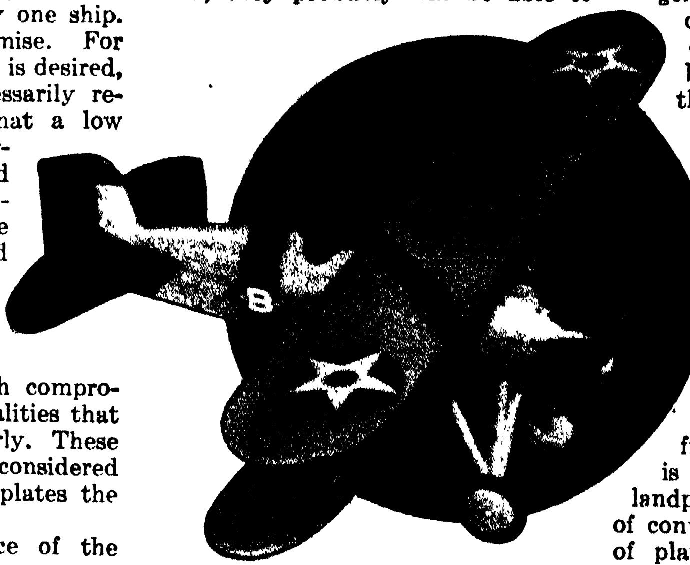
Each type of plane is the result of a number of such compromises. Certain definite qualities that are desirable stand out clearly. These points should be thoroughly considered by the person who contemplates the purchase of an airplane.

The order of importance of the various desirable features is a matter of circumstances and requirements. Take for example, the man who has hired a capable pilot to fly his plane. A high top speed with a reliable pilot will more than offset the combination of a slow landing ship and a less capable pilot.

EACH designer of the 170 licensed types of planes on the market has tried to make his ship the best of its class. He has endeavored to incorporate in it maximum performance, highest efficiency, and the greatest possible safety. Some of the resulting planes are better than others. A discussion of the various features which should be observed and considered may prove of interest to the man who has begun to read airplane advertisements with a personal interest.

The very first consideration is naturally one of money. The sale of any article usually depends upon the cost price. The American custom of time payments has reduced in importance somewhat the economic value of this factor. To a transport and passenger company the initial cost must be subjected to the other items such as safety and payload.

Time payments have been applied to practically all industrial products. Now even aeronautical corporations are taking advantage of this system of financing to increase their sales. The future of aviation is closely related to the youth of the country. It is unlikely that young men will have the capital necessary for the outright purchase of a plane. On the other hand, they probably will be able to make the first payment on a new ship. Final payments will be made with money earned in carrying passengers or in their usual occupations.



OFFERED FOR PRIVATE USE

This Navy fighter, offered as a sport model, is fast and easily maneuverable

Wide price ranges are now available to the buyer. The cost price of a plane is generally a fair index of the power, speed, and finish supplied by the manufacturer. It parallels the automobile to an amazing extent in this respect. Quantity production will naturally lower the sale price, but that day still lies in the future. Planes are available for a sum as low as 900 dollars. If you will recall the discussion concerning compromises, however, you will realize that you get very little but a low initial cost. The plane will lack power, safety, comfort, speed, and payload. You will obtain, however, a low landing speed and economy of operation.

Sales prices run up to six figures. The cost price is influenced most by the power plant with which the plane is equipped. A fairly accurate thumb-rule is available for the uninitiated. Everyone knows the relation existing between the market values of automobiles and their performances. An airplane proportionately equal in comfort, speed, and operation to an automobile can be purchased for approximately three times the cost of that particular car.

THE kind of territory in which a plane is to be used decides the general type which must be purchased. In some localities a choice of land or seaplanes must be made. Here convenience is the criterion. Safety, of course, will influence a transport company to use seaplanes. On the other hand, seaplane terminals are often difficult of access—both for the passengers and for the planes. Corrosion resulting from salt water is difficult to combat. Power being equal, the payload of a landplane is greater than that of a seaplane because of less take-off friction. If the over-water flight is not too long, multiple-engined landplanes can be used for the sake of convenience. The amphibion type of plane is particularly adapted to this class of work. The safety factor of a seaplane is enjoyed while the advantages of a ground terminal are retained.

A young flyer is more likely to desire an open cockpit type of plane. The wind rushing around his ears creates a happy illusion of immense speed and power. This type of ship is best built as a two-seater, though it often comes as a three-place job. Few provisions are made for the carrying of luggage. It is the roadster of the air.

Any number of planes are available for sport purposes. One can be found to suit the experience of any pilot. The latest navy fighter is offered by one company as a commercial sport model.

The cabin ship can be had with any number of seats. Plenty of room is always available for suitcases and picnic lunches. Flying clothes are unnecessary, for ordinary clothing will not become soiled. Conversation is possible and a cigarette can be enjoyed while at the controls. Maps can be studied at leisure without fear that they will blow away. The children will not fall out upon unsuspecting pedestrians.

If a plane is to be used for training, certain definite qualities are required. The best all-around type is the open-cockpit two-seater. A low stalling speed is desirable. High top speed is not necessary for the student. The ship must be sturdy to withstand the terrific shocks to which it will be subjected. In order to permit a thorough course of training, the plane should be designed for stunting. A medium sized power plant is sufficient. Since a student is likely to have minor crack-ups, the training plane must be easy of upkeep. The engine should be accessible from all angles. Ease of maintenance and upkeep are paramount.

The terrain over which your plane is to operate must be considered. If a ship is to operate only at sea-level, its ceiling is of little importance. However, if mountains are likely to be encountered in any of your trips, reserve climbing power must be available.

The Rocky Mountain range was nicknamed "Jenny Divide" in the days when the wartime JN-4 was in its prime. Only a good Jenny could get sufficient altitude to fly over these mountains. Even those that did succeed in making the grade had to dodge around the higher peaks.

As a plane climbs higher, its stalling speed increases. In practical terms this means that a ship must land at a faster speed than normal on a field situated at high altitudes. A long roll necessarily follows a fast landing. Unless a long field is provided, brakes should be installed. Conversely, a long run is also required for the takeoff. Requirements for a high-altitude plane are maximum power, maximum wing area, and minimum weight.

VERSATILE

The amphibion type of plane, used for flights over either land or water is, in some respects, the ideal

The argument concerning the relative merits of the biplane and the monoplane will long continue. Generally speaking, the biplane has more strength than the monoplane. For straight commercial work, however, where no undue stresses are placed on the ship, the monoplane is sufficiently strong. The advantage of all around visibility appears to belong to the biplane in spite of the extra wing.

The monoplane has less parasite resistance because of the absence of brace wires and the extra wing. Accordingly, it is generally faster. On the other hand, where maximum wing area is necessary, as in carrying heavy loads at high altitudes, the span of the single-winged ship becomes enormous and unwieldy. The Boeing Company, which operates over the Sierras, continues to use large biplanes for passenger work. The enormous amount of wing area permits greater loads to be carried and allows a slower landing speed.

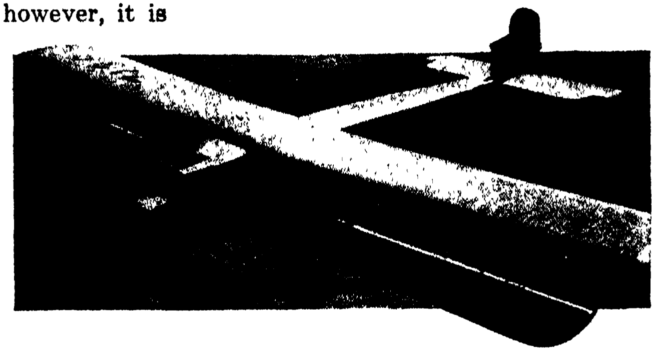
Most people are very apt to think of safety as a quality which can be built into a plane at will. The airplane designer can contribute a great deal to safety. In the end, however, it is the pilot who builds or destroys the reputation of a plane. A poor and untrained pilot may crash a plane which has always been considered very safe.

As long as gravity continues its work, crashes will result. The best pilots have cracked up a plane or two sometime in their career. The desirable plane, then, is one which will best withstand a crash. It is one that will insure the greatest protection to the pilot and his passengers.

Modern steel and alloy construction has replaced wooden strength members. No longer are cockpits likely to fold up on the pilot to pin him in. Fittings and wing bracings should be sufficiently strong to withstand necessary shocks. Component parts of the landing gear such as wheels, axles, and struts should be especially strong. A split-axle type of landing gear is particularly helpful in forced landings. It will straddle bushes and stumps instead of causing the plane to nose up.

Planes can be and have been built that will not spin unless deliberately forced into this condition. Peculiarly, planes that are difficult to spin are also generally very hard to bring under control once they have been worked into one. Unfortunately, a ship of this design invariably sacrifices its maneuvering qualities. Maneuverability is necessary along with a fair amount of stability.

It is assumed that parachutes will be standard equipment for a single-engined plane. Preparations for abandoning a plane in mid-air are best made when selecting the plane. If an open cockpit job, is the cockpit under the wing? A plane that is hard to climb into is even more difficult from which to jump in an emergency. The Department of Commerce now requires one door in a cabin plane for every six passengers.



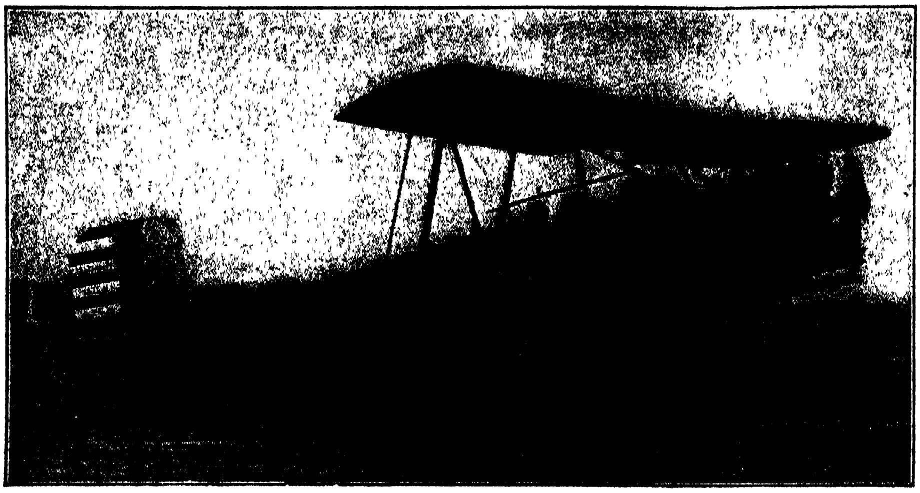
GREATER WING AREA

Relatively larger loads and slower landing speeds are possible with this transport

A plane to be worth consideration must have good visibility for the pilot. Otherwise potential collisions on the ground and in the air will exist. Certain blind spots are unavoidable, but careful design will reduce these spots to a minimum. A ship that maneuvers well permits the pilot to uncover the necessary blind spots quickly.

THE fire menace has decreased due to proper plane and engine design. Battery ignition has been eliminated. Fire walls between the engine and the fuel tanks are protective. Electrical insulation must be such that it can be easily maintained. Gasoline and oil lines should be short and free from vibration, otherwise they will crack and increase the fire hazard. The addition of metal control surfaces in the future will insure control of a plane in the air even though it should catch fire. A pressure fire extinguisher is essential. A liquid (CCl_4) under high pressure in a small cylinder can be released by the pilot in the cockpit. This is discharged through small jets at critical locations about the engine, such as the carbureter.

A minimum upkeep and operating expense is essential to commercial aviation. To the person who operates a plane for pleasure, expenses are a necessary evil to be reduced as low as possible. The lighter the plane and smaller



EASE OF MAINTENANCE AND INSPECTION ARE PARAMOUNT

Since the student flyer will inevitably have minor crack-ups, the training plane must be of a type easily maintained and yet sturdy. It must be capable of "taking much punishment"

the engine, the smaller the expenses. A light plane compares favorably with a medium sized car in gasoline consumption. Fuel consumption increases with power and load. A thorough understanding of engines by the pilot results in increased economy in the operation of the plane.

Hangar fees are nearly constant for the standard size small plane. This increases rapidly, however, with wing span. Folding wings offer some solution to this problem, especially if a person erects his own hangar and has but limited space.

Service stations are now springing up all over the country. It is no longer necessary for each pilot to be able to serve as a mechanic on his plane. True, he must know a few fundamentals and rules in order to obtain proper operation of his engine. Both top and major overhauls can be done by qualified aviation service experts at a reasonable cost. Rigging and fabric jobs can be done equally well by these staffs of experienced men. In fact it is now possible to have practically any kind of repairs made by experts in any section of the country without serious loss of time in waiting.

EASE of maintenance and inspection is essential. Control wires should be run so that there is no danger of their jamming in unguarded pulleys. No trick gadgets which hide working parts should be tolerated. The engine cowling must be such that it can be easily removed and other parts should be easily accessible.

Above all, the plane must be essentially rugged. The best pilots occasionally make poor landings. Poor pilots invariably make poor landings. In either case, the landing gear takes a beating. Some form of oleo shock absorbers will often save a broken landing gear. Another aid is the adoption of oversized wheels and tires. They will cushion a hard landing. In a soft field they will keep the plane from sinking into the soil. A plane so equipped will be able to get in and out of fields the condition of which would otherwise cause a crackup.

Most engine mounts of planes are convertible and the manufacturer allows the customer a choice in the selection of the power plant which is to be mounted in his ship. The amount of power needed depends directly upon the weight of the plane and the performance the buyer desires.

The engine that is chosen, whether for a single or multiple-engined plane, should be one that has proved its reliability in actual service. Past performance will indicate what you might expect from it. As with all machinery the results are proportional to the care and upkeep given them. Flying with wide open throttle may bring you to your destination quicker, but it will bring very little return for your investment. Top speed operation will necessitate more frequent overhauls.

An engine easy of maintenance is especially desirable. It indicates first of all a simple and orderly type of construction. This can be interpreted to mean that the designing engineer knew what he was about. A mechanic can check over and service a "clean" engine installation quickly and in a satisfactory manner.

Comfort while in the air makes flying a pleasure and decreases weariness. It is a short cut to safety, because it permits the pilot to devote his entire time to piloting. All manually operated controls must work easily. A long cross-country flight will develop all points of discomfort to a very marked degree.

The frequency of well-equipped airports in this country makes the endurance of a plane of minor importance. Fuel capacity of from three to four hours is desired, however, in order to reduce the servicing of the plane. The endurance of large transport planes is seldom over five hours, although they could fly much longer. However, it would be necessary to leave many pounds of payload behind in order to carry additional fuel which pays no dividends. It is thus more economical to have the planes land and refuel more often while they carry a larger pay load.

THERE are planes for every one—for every purpose. Prices fit all pocketbooks. Different makes and models satisfy different needs of the buyer. All desirable requirements can not be had in any one plane. Some points must be sacrificed during the design compromise. The prospective buyer, however, will discover a plane in the market of today which will cover the majority of his demands.

After the plane is purchased its performance depends almost entirely upon the pilot. A good flier will fly the ship in a way that will bring satisfaction to the owner. A poor or inexperienced pilot will obtain poor results from any plane. So, in addition to careful consideration in the buying of your plane, handpick your pilot!

Courtesy Bellanca Aircraft Corporation

FOR GENERAL PURPOSES

A typical small cabin plane. Comfort and cleanliness, which make flying a pleasure and decrease weariness, are exemplified in this plane. Many good features are noticeable

Florida's Lusty Infant Industry

Tree Producing Invaluable Tung Oil Now Naturalized American

A CENTURIES-OLD Chinese industry may soon be forced to yield its hold on the American market to an infant competitor in Florida, according to Professor M. Ogden Phillips in an article in *Economic Geography.* Each year American manufacturers pay from 10,000,000 dollars to 15,000,000 dollars to Chinese producers for this oil which is superior to linseed oil |for the production of high grade paints and varnishes, and is used in the making of linoleum, insulating materials, soaps, water-proof cloth and paper, and many other products.

The first tung oil tree in Florida was planted in 1906 and in 1913 the first tung oil to be produced on the American continent — 2.2 gallons — was extracted from a bushel of the seeds. In the fall of 1928, over 160,000 trees had entered commercial production. Florida tung oil trees three and a half years old have produced over 300 nuts per tree in contrast to 130 nuts from a 10-year-old tree in one of the best groves of China. Certain individual trees in Florida have produced as much as four gallons (32 pounds) of tung oil in a year.

The peculiar qualities of tung oil make it superior to linseed oil and give it a higher market value. Flax, from which linseed oil is obtained, must be planted each year while tung oil trees are planted only once for a production of 25 to 30 years. Flax is susceptible to disease when planted continuously on the same land and is hard on the soil, requires plow cultivation and thus invites erosion, and must be harvested promptly when mature. Tung oil nuts can be left on the ground for weeks and gathered at the convenience of the grower, and the trees retard erosion of the soil.

The crop of nuts is gathered, husked mechanically, and then allowed to dry thoroughly. The seeds are then cracked and pressed whole without removing the seed coats. Before pressing, they are heated sufficiently to make the oil flow readily.

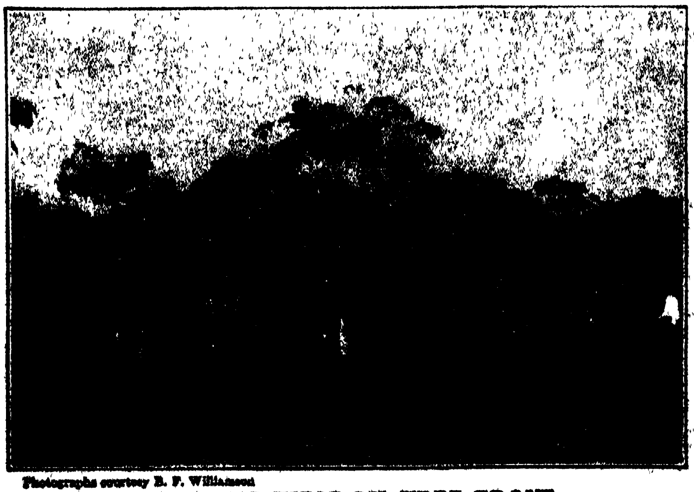
The maximum yield of oil from flax seed is 255 pounds per acre while the yield from an acre of nine-year-old tung oil trees is 1800 pounds.

◄ A YOUNG PRODUCER

The tung oil tree does not differ much in appearance from common fruit trees

A HEALTHY START IN LIFE ►

Tung oil trees are grown in outdoor nurseries, then planted 116 trees to the acre



Photographs courtesy B. F. Williamson

A TYPICAL TUNG OIL TREE GROVE

Trees begin to bear within three or four years. After the seventh year, when crowding begins, they are thinned to 60 trees per acre

DRYING PREPARATORY TO PRESSING

Part of a recent crop of tung oil nuts. They are stored until dry. It will be noted that they are about the size of small apples

Voices Across the Sea

The Successful Exchange of International Programs Places Another Milestone on the Path of Radio Progress

IT will probably surprise some people to learn that the groundwork for the recent international exchange of radio programs was laid about the time crystal radio receiving sets were the rule rather than museum curios. Ten years ago, when engineers and business men first realized that the baby radio showed promise of becoming a giant in a decade, engineers of the General Electric Company, the Westinghouse Electric and Manufacturing Company, and the Radio Corporation of America began to experiment in long distance transmission. These engineers declare that engineers abroad should share equally in the glory of the achievement.

All photographs courtesy National Broadcasting Company, Inc.

THE RECEIVING END ON LONG ISLAND

In these two buildings the radio signals from England, Holland, Germany, and Sweden are monitored daily. All foreign programs to be rebroadcast are picked up at this point

First experiments were conducted with the so-called long waves, many of them of the same frequency as those used for regular broadcasting in the United States today and others even longer. Then the short waves, more or less overlooked, were picked up by the experimenters and it was discovered that they had tremendous possibilities for covering great distances. To date, short-wave transmission is considered the best available method of sending radio signals from continent to continent.

THE early work of the engineers who dreamed of a world united by radio signals was more or less haphazard. Haphazard for engineers, that is. The first objective was to exchange speech with Europe by means of radio. This, after a number of experiments, was accomplished in 1924, when the British Broadcasting Company relayed a program from KDKA for the first time.

While these experiments in long-range work were going on, regular broadcasting was developing at a tremendous speed in the United States. Distortion of sound was being eliminated and in a short space of time the presentation of a symphony orchestra on the air was as much a matter of routine as the reading of weather reports.

The ether path across the Atlantic proved to be a rough one at best, the engineers discovered, and they quickly found out that music was too fragile a thing to send long distances without serious things happening to it. And the rebroadcasting of the music from one continent for listeners in another continent was the immediate goal of the advocates of international exchange of radio programs. Equipment was improved, huge sums were appropriated for experimental work, and various types of transmitters, receivers, and antennas were tested under all conceivable conditions.

CONTROL BOOTH

All programs are monitored by studio engineers before being transmitted by the wire lines to the network

WITH the organization of the National Broadcasting Company several years ago, the work of the three aforementioned electrical groups was co-ordinated and, as a result of this co-ordination, progress was speeded. Engineers began to pick up programs from England and Germany and at times the reception was comparable to that from regular commercially operated transmitters in the United States. Little of this was revealed to the public. Then on February 1, 1929, with only a few hours' notice, a program of symphonic music, originating in London, was successfully picked up and rebroadcast through a network of NBC stations. The dream of the engineers was realized. From time to time other programs from England were heard through the American network and later came programs from Germany and Holland. Rarely were these programs planned as much as a week ahead—the engineers still were not certain of what they could do.

Christmas Day, 1929, marked the beginning of a new epoch in international exchange of radio programs. More than a week before Christmas the NBC announced that it would attempt to rebroadcast, within a few hours time, special programs originating in England, Holland, and Germany and that American programs would be sent on short waves to those countries. Though fairly confident that the programs would be received successfully, the word "attempt" was not eliminated from the announcement.

Christmas Day came and with it came three programs from abroad. The reception was better than even the most optimistic had expected. Throughout the quality was comparable to the reception from domestic broadcasting stations and the American listeners' approbation was expressed in no uncertain terms.

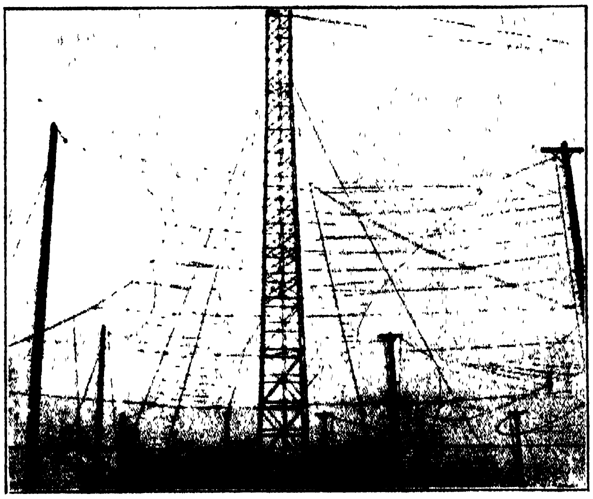
There were several reasons for selecting Christmas Day for the great experiment. One was in order to send and receive messages of international goodwill. Another was that the atmospheric conditions were favorable. At this time the most exhaustive survey of north Atlantic radio transmission problems ever attempted had just been completed and the engineers had data never before available. Two years previously a complete record of atmospheric conditions and other matters relative to trans-oceanic broadcasting had been started by engineers. The next year a similar record was kept and the records of the first year checked against the second year's survey. The data thus obtained enabled engineers to figure on what conditions to expect at a given time, current conditions being taken into consideration.

SOME confusion seems to exist in the minds of listeners as to the exact path followed by a radio program in its journey from a foreign studio to an American home. It is well at this point to trace the route of the program. The presentation from London, received in the United States the afternoon of Christmas Day, may be taken as an example.

The artists gathered before a microphone in the London studios of the British Broadcasting Company. The program was picked up for transmission and was heard by British listeners through the regular BBC transmitters. American listeners, however, did not hear the program from the same transmitter used to send it to English listeners. Instead, the program went on land wires to station G5SW, experimental short-wave transmitter of the BBC located at Chelmsford on the coast of England. From this point it went on the air on short waves. The wavelength selected was one that long and careful experiments had shown was best picked up by the experimental short-wave receiving plant of the Radio Corporation of America at Riverhead, Long Island. These signals from abroad, when received at Riverhead, had not sufficient strength to be passed on directly to American listeners by re-transmission. At Riverhead they were carefully monitored, rectified, and then amplified and sent to the main control room of the NBC at 711 Fifth Avenue, in New York City. Here they were subjected to further attention and again amplified before being sent out on the thousands of miles of network wires that carry programs to the scattered transmitters. Amplified again at the transmitters, the program started on its last lap through the ether, to be picked up and reproduced by the receiving sets in American homes. Despite the circuitous route, the continuous amplification, and the necessary monitoring, the quality of the program heard in America differed little, if at all, from that heard by British listeners.

THOUGH started on their transatlantic journeys from different short-wave transmitters located in the respective countries, the programs from Holland and Germany followed the same general route.

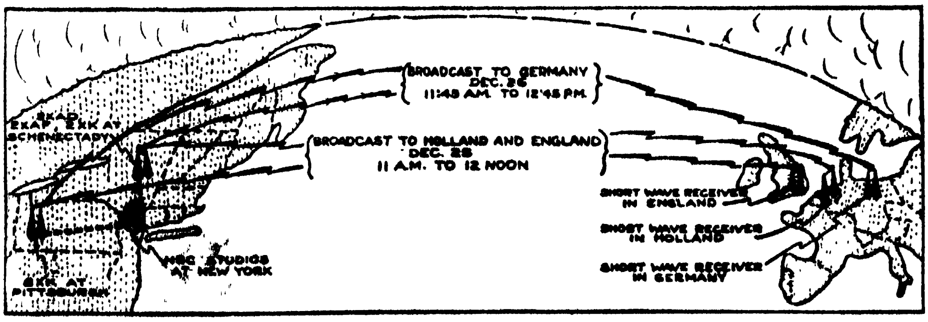
Of the special equipment used in this international exchange of programs little can be written. Much of it still is being improved and construction details are jealously guarded secrets. Though engineers have known for a long time that static can no more be eliminated than snow or rain, they have learned much about shielding the delicate signals from atmospheric disturbances.

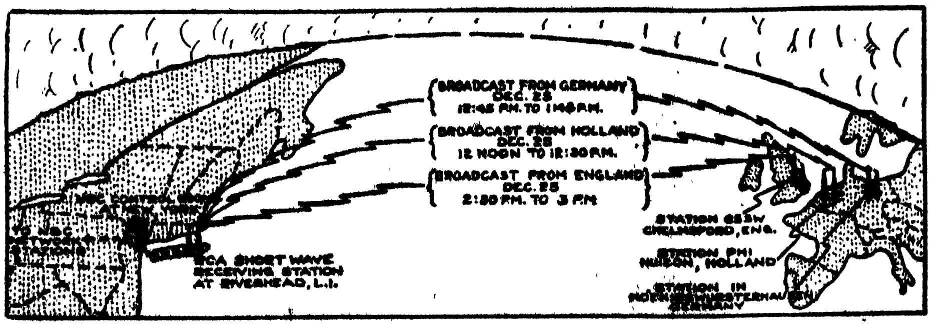


ANTENNAS

This forest of wires intercepts the short-wave signals from abroad, for rebroadcasting in the United States

Standard antennas do not give the best results in the reception of short-wave signals, engineers discovered, and the result has been the development of a new type of antenna, covering acres of ground and resembling a huge spider web. Similar problems in every technical phase of the program interchange brought radical changes and developments in equipment. There is as much difference in the equipment used for regular broadcasting and for short-wave transmission and reception as between a stock model automobile and a machine built exclusively for racing.


2XAD
2XAF, 2XK AT SCHENECTADY
8XK AT PITTSBURGH
NBC STUDIOS AT NEW YORK
BROADCAST TO GERMANY DEC. 26 11:45 A.M. TO 12:45 P.M.
BROADCAST TO HOLLAND AND ENGLAND DEC. 25 11 A.M. TO 12 NOON
SHORT WAVE RECEIVER IN ENGLAND
SHORT WAVE RECEIVER IN HOLLAND
SHORT WAVE RECEIVER IN GERMANY

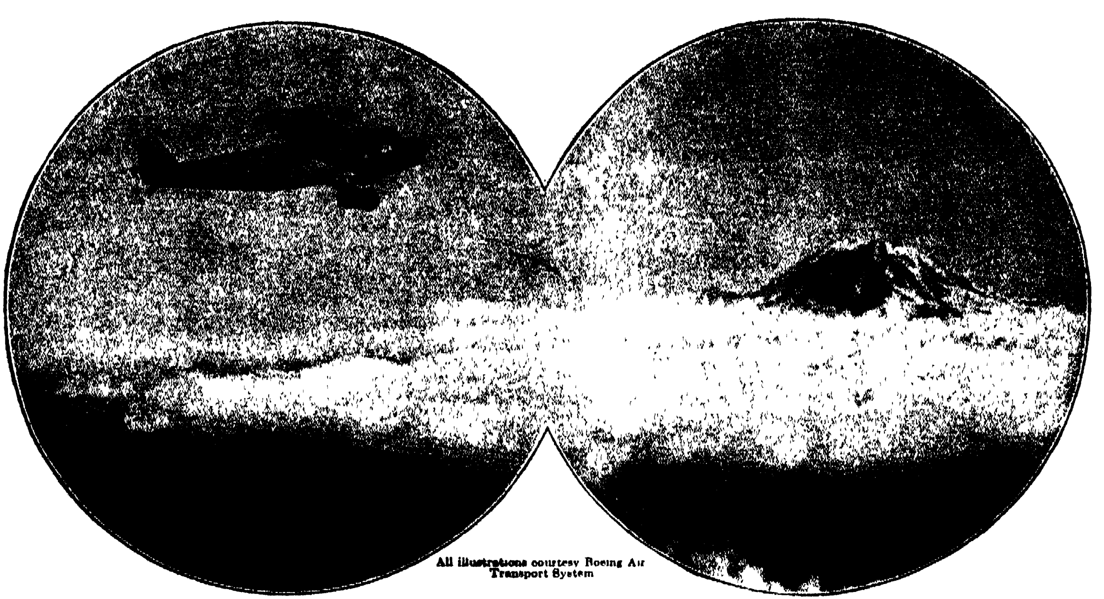

NBC CONTROL ROOM AT NEW YORK
TO NBC NETWORK STATIONS
RCA SHORT WAVE RECEIVING STATION AT RIVERHEAD, L.I.
BROADCAST FROM GERMANY DEC. 25 12:45 P.M. TO 1:45 P.M.
BROADCAST FROM HOLLAND DEC. 25 12 NOON TO 12:30 P.M.
BROADCAST FROM ENGLAND DEC. 25 2:30 P.M. TO 3 P.M.
STATION G5SW CHELMSFORD, ENG.
STATION PHI HUIZEN, HOLLAND
STATION IN KÖNIGSWUSTERHAUSEN GERMANY

TRANSMISSION AND RECEPTION

The upper illustration shows diagrammatically the Christmas broadcast from this country to Europe. The lower drawing indicates the reception and rebroadcasting in this country

Of great assistance to the progress of international broadcasting has been the establisment of new and powerful short-wave transmitters in Europe. German broadcasters recently put into service a transmitter designed especially to send programs to America. England and Holland have similar transmitters and other European nations are expected to follow the lead.

While much work remains to be done before programs from abroad are heard on as regular a schedule as those originating in American studios, the actual pioneering is history and the public has had proof that it is possible.



All illustrations courtesy Boeing Air Transport System

FAR ABOVE THE CLOUDS

To the right is Mount Rainier-Tacoma, 14,408 feet above sea level. The three motors of the transport plane at the left enable it to rise above the crest of this famous mountain

An Air-Transport Operator Speaks

"It Is the Operator's Obligation to Employ Every Known Device to Make Air Transport Safe and Speedy"

By P. G. JOHNSON*
President Boeing Air Transport System

WHEN at the end of 1929, pilots of the Boeing system, operators of the two longest airmail routes of the country, completed 8,000,000 miles of flight, the first time any company in the United States has achieved that honor, it prompted reflection on the lessons learned in flying these 8,000,000 miles.

The Boeing Airplane Company, which started 13 years ago with a one-room factory employing 30 people and grew into the largest plant in the United States devoted exclusively to the production of airplanes, had done no commercial flying prior to 1927. We had been making airplanes, most of them for the government, but when the government decided to retire from the operation of airmail planes and called for bids on the Chicago-San Francisco leg of the transcontinental route, we decided to become operators.

We knew in a general way that this route (which is the longest regularly operated mail-passenger line with daily service in the world), would call for a heavy investment, the best type of plane which could be built or bought, and eternal vigilance and care in the operation of these planes. We put in a bid and won the award.

We then found that, to operate this route successfully and build up patronage, the types of plane then available would not be adaptable for our use. In 150 days we designed and built 25 mail-two-passenger planes, distributed them along the line with preliminary test flights over the route, organized operation and traffic departments, and at midnight of June 30, 1927, started flying the airmail. Now we have more than 8,000,000 miles behind us. The lessons we have learned and the methods employed have a bearing on air transport operations in general.

The theory of our system is that the mail must be put through on schedule if possible within the margin of safety. That we have been quite successful is evidenced by the fact that in the flying of 8,000,000 miles there have been only three fatalities. Our plan of servicing planes really begins at the factory, because the designers have the benefit of suggestions from men who are flying our planes 10,000 miles a day. Consequently, our high-speed, large-capacity cargo planes, the mail-two-passenger, mail-four-passenger, and large tri-motored transports, represent not only the designers' opinions of what a plane should be but incorporate suggestions received in actual operations.

IT requires a fleet of 53 planes and 64 pilots to operate these two lines, and we are as careful in the choice of pilots as in the equipment. It is our policy not to employ a pilot who has had less than 2000 hours' experience. Most of our pilots have had from four to eight thousand hours in the air, and they are men who know how to act quickly and correctly when emergencies present themselves.

Another feature of our operations, which is quite different from that of the ordinary air transport line, is our extensive night flying. Each night our planes fly 4600 miles between dusk and dawn, and of our total mileage of 8,000,000, approximately 3,600,000 were flown at night.

Recently we completed eight month's successful operation of the first night tri-motored passenger transport service on a regular schedule over an established airway. We determined that this type of dark-to-dawn flying was not only feasible, but that the public will patronize these night planes when flown by an experienced company with proper equipment and personnel.

It is logical to expect that the percentage of night flying done by the transcontinental line will increase, because air transport reaches its maximum efficiency when it extends over the entire 24 hours.

By flying at night we are able to deliver mail and passengers between points as distant as 1200 miles, without the loss of any business hours. Night flying, however, calls for supplementary equipment and also the training of pilots for this type of flying.

Another important thing that we have learned from flying 8,000,000 miles is that we can now get more

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*See "Among Our Contributors," page 341.

UNITED AIRPORT, BURBANK, CALIFORNIA

Modern terminals such as the one shown above are essential to the safe and consistent operation of a transport line. The dust-proof runways 300 feet wide are prominent features

service out of airplanes than formerly. Until recently we used five planes, one for each division, in transporting a load of mail and two passengers from Chicago to San Francisco. Because of improved equipment and engines, and more experienced personnel, we are now using two planes to do the work of these five. This means that we have made a step towards reducing the unit cost of transportation, a factor in promoting the use of the airplane.

Our experience has also taught us that most of the delays to air transport occur on the ground, and are entirely apart from structural or engine troubles, which account for only 4 percent of delayed schedules. The chief reason for delay has been the uncertainty as to flying conditions due to weather.

For months we experimented with a radiophone system, so that the pilot could have voice communication with the ground. We wanted a set which would be workable under all conditions. During the months of tests, we ran into many exasperating situations. We found that reception varied at different altitudes; that there were areas of radio shadows, skip distances, and blind spots; spark plugs and motors set up disturbances which had to be eliminated.

Our communication department, however, whipped those problems. We are now completing the most extensive radiophone installation in both ground stations and plane equipment used by any air transport line in the world, and by the time this article is published we expect to be operating 22 ground stations in nine states, and pilots on our Chicago-San Francisco and Los Angeles-Seattle planes will be able to have continuous voice communication with the ground, and between planes in flight. Radiophone is a profitable investment because of its great safety factor and the extent to which it expedites the service.

PILOT JONES SHIP NUMBER 286 EASTBOUND. WHAT ARE WEATHER CONDITIONS AHEAD ?
ALL STATIONS BETWEEN HERE AND CHEYENNE REPORT CLEAR WEATHER. CHEYENNE REPORTS RAIN STORM APPROACHING FROM NORTHEAST.

RADIO PLAYS ITS PART

Radiophone systems are important links in airlines. The pilot can talk to ground stations 200 miles distant

Our pilots are talking from an altitude as great as 12,000 feet to ground stations 200 miles distant. This voice communication between the pilot and the ground, and between pilots of planes in flight, has these advantages; it adds much to the safety of flying; reduces the number of emergency landings due to uncertainty as to weather ahead; enables pilots on regular routes to complete a larger number of scheduled trips on time; and increases the pay load by reducing the amount of excess gasoline now carried to give pilot ample cruising radius when he is uncertain as to weather. Radiophone is also of considerable value in dispatching planes and giving orders to pilots in the air.

Our pilots on the Chicago-Oakland-San Francisco route not only have the above described voice communication between plane and ground, but can take advantage of directive radio beacon and weather report service maintained on the transcontinental route by the Department of Commerce. In this system, a radio beam is broadcast by transmitters known as equi-signal beacons. Transmitters employ two cross loops, radiating a characteristic "dot and dash" signal. When dots and dashes blend into a continuous series of "dashes" the pilot knows he is on the course fixed by the beacon. If he hears "dot-dash" he knows he is to the left of his true course, and when he hears "dash-dot" he learns he is to the right.

We have also put into the field to supplement the present Federal weather reports several mobile weather broadcasting radio trucks. They are placed north and south of our east and west transcontinental line, at points where they can detect storms which will sweep down on our line, and by advising us in advance we can know when to keep our planes on the ground, or when to leave our regular route and fly around the storms.

We have made these preparations in advance of starting, this spring, a 20-hour night and day passenger service between San Francisco and Chicago, using 18-passenger (or 12-passenger and mail) planes. It is the operator's obligation to employ every known device to make air transport safe and speedy, as it is logical to expect that the airplane will be developed to the point where it will be commonly used not only for the transportation of mail and express, but of passengers as well.

We have not defeated every problem in our path, but the progress we have made in the last few years would indicate that the words "it cannot be done" have been stricken from the lexicon of the air-transport operator.

ON A LONG FACE IN INDIANA

With the new carbon dioxide shell, the coal may be shot as soon as it is undercut, the machines following each other closely, as shown here. On the left is the loading machine; next comes the shot drill; then the mining machine; and at right, the new shell

Blasting Coal Without Explosives

Inert—Flameless and Non-inflammable—Carbon Dioxide in New Shell Blasts Coal With a "Slow" Heave

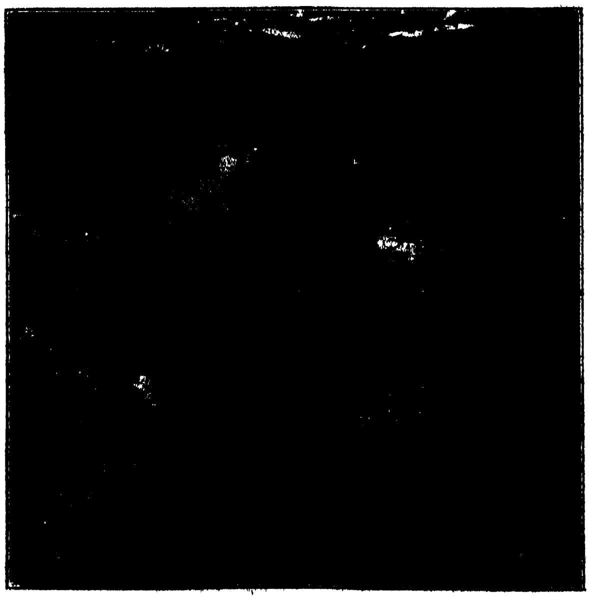
By FRANK H. KNEELAND

IN some kinds of industrial blasting, shock of detonation is of distinct advantage; in others it has a decidedly adverse effect and should be avoided by all possible means. Shock produces a shattering effect on the material blasted. Consequently, dynamite or some other "quick" explosive is usually employed in quarrying rock or other mineral where it is desired to break it into small fragments. If large pieces are wanted, a "slow" explosive gives far better results.

In coal mining where the lump sizes usually bring a higher price than the slack or fine material, a comparatively slow, heaving action gives much better results than the quick, shattering, disruptive effort of high explosive. For this reason black gunpowder has been almost universally preferred in the past by miners and mine operators.

A NEW device on the American market, particularly applicable to coal production, is not an explosive and is not so classed by the United States Bureau of Mines, although it possesses some of the general characteristics of explosives. This device, known as Cardox, utilizes the expansive force of an inert and harmless gas for breaking down the coal at the working face. No smoke, flame, or noxious odors are produced, and the results obtained are unquestionably superior to those afforded by even the slowest of explosives.

The means employed to render an inert gas effective for this purpose are extremely simple. If we could make a miniature steam boiler—small enough so that it could be loaded into a bore hole like a charge of explosive—provide it with one weak plate that would rupture under a predetermined pressure without injury to the rest of the boiler shell; if we could fill this boiler with water; and if, after it had been placed within the coal to be shot down, we could quickly apply enough heat to evaporate the water, the pressure within the boiler shell would rise until the weak plate would give way. In other words, the "boiler" would "explode," and the surrounding coal would be broken and heaved down by the expansive force of the steam. This action on the coal would be far less disruptive than that of any explosive, just as the ordinary industrial boiler explosion is less destructive than that of a powder magazine.



IN LARGE LUMPS

The comparatively slow shot of the Cardox shell does not shatter the coal into cheapened small grades

Roughly speaking, the Cardox shell or cartridge is nothing more nor less than a small boiler provided with a weak plate and an instantaneous furnace. The "boiler" is a hollow, one-piece forging of high-grade alloy steel.

IT is roughly bottle-shaped and provided with a filling valve at one end. The opposite end, or mouth, is closed by means of a soft steel disk—the weak plate in the boiler shell—which rests against a hardened steel shear ring. The joint gasket of fiber, disk, and shear ring are held securely in place by means of a steel cap that is screwed onto the shell neck.

The "instantaneous furnace" previously mentioned consists of a paper tube containing chemicals—sodium chlorate, charcoal, and powdered aluminum—capable of reacting with each other and producing intense heat. This heater also contains an ordinary electric match-head or squib, the wires from which terminate at either end. When in place within the shell, one end of this heater rests within and makes electrical contact with a support that is insulated from the body of the shell, while the other end makes similar contact with the sealing disk, which is in electrical contact with the shell body.

Because of its low disintegration energy—latent heat of vaporization—as well as its inert nature and harmlessness while in the gaseous state, carbon dioxide is the material employed for charging the Cardox shell.

Today carbon dioxide is a fairly common article of commerce. Its use in soda fountains is familiar to everyone. It may be readily liquefied under pressure, provided its temperature is kept below the critical temperature, approximately 88.7 degrees, Fahrenheit. Above this critical temperature, it cannot be liquefied regardless of the pressure placed upon it. This is only a little above normal coal mine temperature, and, consequently, only a small amount of the heat evolved by the heater is taken up in raising the temperature of the liquid contents of the shell while the rest goes to superheat the gas formed when the critical temperature has been reached.

DEPENDING upon its model, the shell is capable of holding from 3 to 4½ pounds of liquid carbon dioxide. The heater normally contains from 125 to 175 grams of heating compound, the exact weight varying with the thickness of the disk employed and the charge of carbon dioxide. These three elements — weight of charge, weight of heater, and thickness of disk—may be varied to suit the nature and texture of the coal to be brought down, and best results are secured when a proper balance between the three has been established.

In practice a shell is brought to the charging station where the heater and disk are renewed. The shell is then placed in a rack and liquid carbon dioxide pumped into it at a temperature of about 0 degree, Fahrenheit, and a pressure of approximately 900 pounds per square inch. When the desired charge has been loaded into the shell (as determined by weighing) the filling valve is closed, the shell removed from the rack, and the cap covering the valve end screwed lightly into place.

The shell may now be taken to the working face. An electric post drill readily drills a hole in the coal sufficiently large to receive the shell. As the shell is slipped, discharge end foremost, into this hole, a terminal plug, with firing cable attached, is inserted in its outer end. Thenceforward the shell is treated exactly as if it were a charge of explosive. It is shoved to the back of the hole and tamped in place. The lead cables are connected to the firing cable; the operative retires to the nearest break-through, connects the firing cable to the terminals of a blasting machine, shouts a warning such as "fire!" or "fire in the hole!" to other workmen who may be in the vicinity, and, after a slight pause, gives the machine handle a vigorous twist.

PREPARING THE SHELL
An operative is here shown inserting into the shell the paper tube—the "furnace"—containing chemicals

The current from the blasting machine ignites the match-head which in turn starts the reaction between the chemicals of the heater. By this means in approximately 1/85 of a second as nearly as it can be measured, the liquid carbon dioxide within the shell is vaporized and the pressure jumps from the loading pressure of 900 pounds per square inch, to several thousand pounds per square inch, the exact pressure depending on the thickness and shearing strength of the disk. In any case this pressure exceeds the resistance of the disk and its central section first bulges and then shears against the hardened steel shear ring that supports it. This central portion or slug is caught and retained within the discharge cap while the gas that is liberated by the disk's failure escapes through the vent holes against the coal, which is broken and heaved down by the expansive force of the liberated gas.

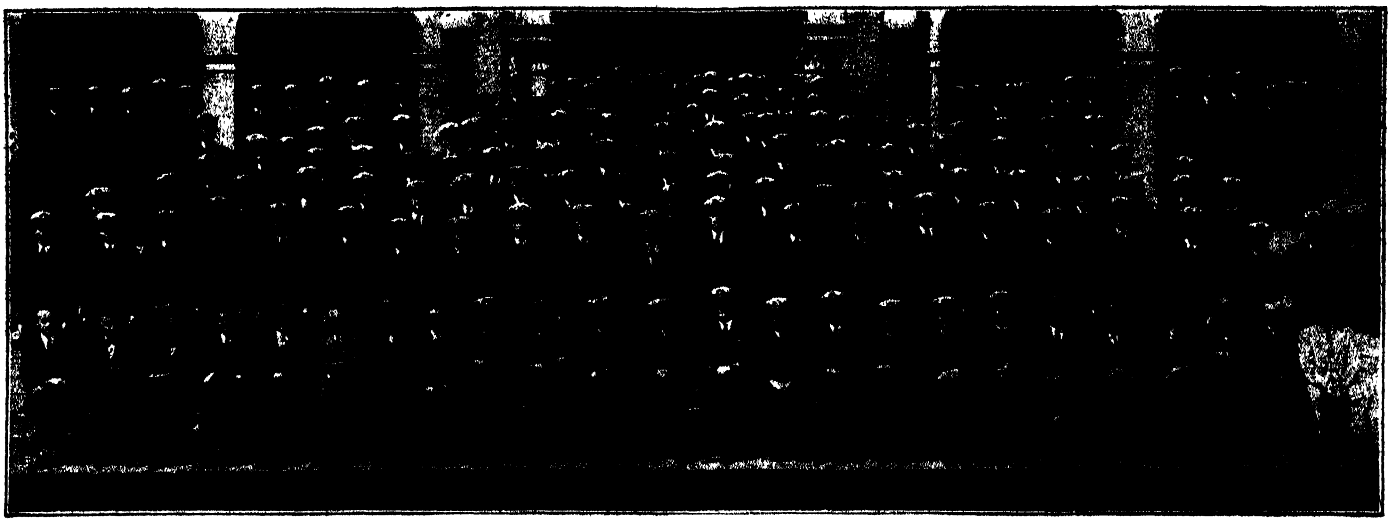
Inasmuch as carbon dioxide is a colorless, odorless, tasteless, and inert gas, its presence in the atmosphere at a coal face is not perceptible to the senses except through its temperature. Thus the air in a place that has just been brought down by this means frequently is perceptibly cooler than before the "shots" were fired.

Since carbon dioxide is inert chemically, it can be breathed in small quantity without injury. The only ill effect of its presence in the air is its dilution of the normal oxygen content. Analyses of samples of the air at the working face taken as quickly as possible after a Cardox shot or series of shots had been fired have never shown more than 2.6 percent of carbon dioxide. The amount of dilution ordinarily encountered seldom exceeds .5 percent. Either of these percentages is negligible so far as respiration and ill effects on the human body are concerned.

INSERTING CABLE TERMINAL
The cable is large so that shell may be pulled out of the fallen coal by its aid

AS has been stated, the release pressure of this gas varies with the thickness of the disk, ranging from 10,000 to 20,000 pounds as against the 50,000 to 55,000-pound explosion pressure of black powder and the 100,000 to 150,000-pound pressure for permissible explosive. The initial shock that is dealt the coal is thus far less with Cardox than with even the slowest of explosives and the shattering effect and amount of fine coal produced is proportionately less, so that more lump and less slack is produced. Not only this, but the shock and jar imposed on the roof strata is less violent and less timbering is needed.

Another and, in some cases the most important advantage possessed by this means for bringing down coal, is its safety in the presence of explosive mixtures of air and fire damp, or methane. After test by the United States Bureau of Mines, Approval Number 1 was issued covering this cartridge as a permissible blasting device. It is thus not even classed as an explosive. Important as this safety feature may be, however, there are many coal mines in the United States and elsewhere in which methane is seldom, if ever, found. To these, the improvement in quality of the product that its employment effects will be the important factor governing its adoption. To many mines this quality improvement is sufficient to spell all of the difference between an operating profit and a loss.



THE POST-GRADUATE SCHOOL, CLASS OF 1930

The Cultured Naval Officer

Few People Realize the Broadness and Completeness, Technically and Culturally, of Our Naval Education System

By CAPTAIN W. D. PULESTON, U. S. N.*

IN our naval service tradition has played a larger part in forming the character of the personnel, commissioned and non-commissioned, than is generally realized. Paul Jones' defiant "I have just commenced to fight"; Decatur's toast "My country, may she ever be right, but right or wrong, my country"; Craven's debonair bow to death, trapped in the conning tower, with his "After you, pilot"; and Farragut's inspiring "Damn the torpedoes, go ahead"; built up and continue to sustain the morale of the Navy, without which professional skill would avail little.

Accounts of these incidents, and of numerous others less known to the public but familiar to the naval service, originally were passed along by word of mouth from one naval generation to the next until they have gradually become enshrined in the mind of the service and serve to incite a laudable ambition among their younger hearers. But commissioned naval officers must also have thorough technical knowledge of their ships and weapons else their pride and daring will only bring them more quickly to defeat and expose their country to ruin; and unfortunately, inspiring tales of the exploits of previous leaders will not bestow their abilities upon their professional descendants.

The commissioned officers of our Navy in the Revolution came mainly from the masters and mates of the colonial merchant marine and during the almost continuous maritime wars of our colonial days many of them became more or less acquainted with the customs and discipline of the British Navy. They knew enough of gunnery to fight with the guns that were a part of the equipment of almost all merchant vessels of that day and they were bold and skillful seamen and navigators. Most officers of this type were inclined to underestimate the need of systematic education and training, although Paul Jones, from the beginning, asserted that a naval officer, in addition to being a "capable mariner," should be "a gentleman of liberal education, refined manner, and punctilious courtesy, with the nicest sense of duty."

A FEW other of our earlier officers appreciated the necessity of proper education for naval officers, and commencing with the Honorable William Jones in 1814, nearly all our Secretaries of the Navy advocated the establishment of a naval school ashore where systematic instruction could be given midshipmen. Although most of the senior officers were opposed to the education of midshipmen ashore, they nearly all took pains to instruct their midshipmen in such professional subjects as seamanship and navigation, and instilled in them at an early age the strict code of the sea.

In the decade prior to 1845 there was much agitation in the public press about conditions in the Navy. Various groups of midshipmen from time to time memorialized Congress about their grievances, and the mutiny planned on the *Somers* and the subsequent hanging of Midshipman Spenser attracted the attention of the country to the unsatisfactory conditions surrounding the midshipmen afloat. The Navy in 1839 received its first appropriation for building steam vessels and even the crustiest old sea-dog was obliged to admit that a knowledge of steam could not be acquired at sea on a sailing ship. Forward-looking officers immediately realized that the advent of steam gave an additional reason for the establishment of a naval school ashore. But even these developments would not have established a naval school except for the support of Secretary Bancroft, who overcame the opposition in the Navy, borrowed a fort from the Army at Annapolis for its first home, ran it for a term under the general authority of the Secretary of the Navy, and in 1846 persuaded Congress to confirm his action and make the first annual appropriation for the Naval Academy. George Bancroft, scholar, historian, and statesman, gave to the Navy the Naval Academy, and to his country since its formation, a continuous supply of carefully trained junior naval officers.

The first course at the Naval School included English grammar and composition, arithmetic, geography, history, navigation and the use of steam, the Spanish and French languages; provision was made for its future improvement by the clause "and such other branches desirable to the accomplishment of a naval officer as circumstances may render practicable." Between 1845 and the Civil War the Naval Academy gradually enlarged and improved its curriculum. Throughout this period the Naval Academy was considered sufficient to satisfy the educational needs of the Navy.

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* See "Among Our Contributors," page 341

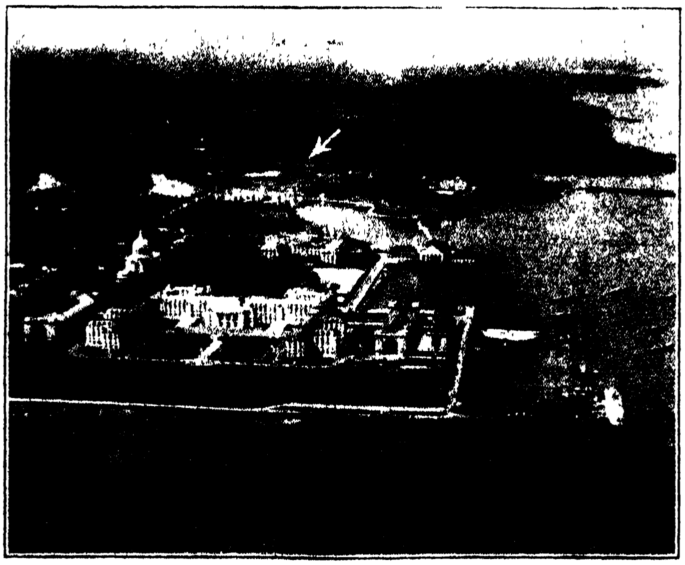
During our Civil War the capture of Charleston was greatly desired by Lincoln for military and political reasons, but the Navy alone was unable to reduce it. Among the young naval officers who witnessed the Navy's futile efforts to capture Charleston was Lieutenant Commander Stephen B. Luce, who, later, in command of a small gunboat, covered the passage of Sherman's Army across the Savannah River.

After the Civil War, Luce, while on duty as Commandant of Midshipmen at the Naval Academy, was one of the founder members of the United States Naval Institute, the object of which is "the advancement of professional, literary, and scientific knowledge in the Navy." In a broad sense the Naval Institute was the first post-graduate educational institution in the Navy. It met a real want and it continues to flourish to the present day.

THE success of the Naval Institute inspired Luce to additional efforts, and in 1877 he wrote the Secretary of the Navy advocating the establishment of a post-graduate school where officers could be given instruction in the art of war. In 1884, Secretary Chandler established the Naval War College and appointed Luce as president.

About 1873 the automobile torpedo was invented and shortly afterwards the Navy Department established a torpedo class at Goat Island, Newport, Rhode Island, to study and develop the new weapon. The War College and the Torpedo School were the first strictly post-graduate schools of the Navy. The Naval War College was also the first institution primarily devoted to the study of naval warfare in the world although Germany and other European countries had their Army War Colleges.

Thus the Naval War College, which is the apex of the present naval educational system, was the second educational institution in point of time to be established. Later other post-graduate schools began to appear, for the period of naval reconnaissance was at hand; and although there continued to be some opposition in the service to additional schools, it was gradually overcome.



UNITED STATES NAVAL ACADEMY

An air view of the Naval Academy showing the United States Naval Post-graduate School in center background, under the arrow

After the World War, the Department detailed a Junior Class to the War College to be trained for duty on the staffs of high commanders and for command of small units. This new course provides junior officers trained in staff duties, and directs the attention of a large body of junior officers to the study of war at a comparatively early age when their minds are fresher and they can readily comprehend new subjects.

The Corps of Naval Constructors were next to realize the need of special post-graduate work, and in 1881 Rear Admiral Capps, then a junior officer, was sent to Greenwich, England, to study naval architecture and kindred subjects. Later prospective naval constructors were sent to Glasgow, Scotland, and this custom persisted until 1901, when candidates for the Construction Corps were sent to the Massachusetts Institute of Technology. This procedure still obtains, and yearly a quota of prospective naval constructors enters Massachusetts Institute of Technology. Some years later the Corps of Civil Engineers selected Rensselaer Polytechnic Institute for the post-graduate education of candidates for its corps, and today both these institutions can be regarded as an integral part of the naval post-graduate system.

AS early as 1893, the Bureau of Medicine and Surgery began a post-graduate course for medical officers at the United States Naval Laboratory, Brooklyn, New York. This subsequently developed into the Naval Medical School affiliated with the Naval Hospital at Washington. In addition, this Bureau has, since 1920, sent officers to civilian institutions, medical centers, and hospitals for special post-graduate courses.

About 1900, interest in post-graduate education began to quicken throughout the Navy because the great improvements in ship design, marine engineering, electricity, ordnance material, and naval accessories, and the increase in educational standards throughout the United States made it plainly evident that four years at the Naval Academy was not sufficient to give officers the technical knowledge necessary to carry on the various duties to which they might be assigned. The Department responded to this service reaction by establishing in 1909 a "School of Marine Engineering" at Annapolis, with a technical curriculum and a staff of instructors about half of whom were civilians, eminent in their own specialties. In 1912 the curriculum was extended to include courses in ordnance and gunnery, electrical engineering, wireless telegraphy, naval construction, and civil engineering.

The World War caused a temporary suspension of this school, which reopened in 1919, with a more comprehensive curriculum based upon:

(a) A one-year basic course taken by all students at the Post-graduate School in Annapolis during which they refresh their knowledge of mathematics, physics, thermo-dynamics, and perhaps languages.

(b) Specialized courses of one or two years given at the following universities, where students concentate their energies on their particular subjects: Columbia University gives three of these courses—mechanical engineering, electrical engineering, ordnance optics. Massachusetts Institute of Technology furnishes to naval students courses in aeronautical engineering, ordnance design, ordnance torpedoes, and aerology, of one year each, and naval construction of two years. Both Harvard and Yale provide courses in communication engineering which include instruction in telegraphy and wireless telegraphy. Rensselaer Polytechnic Institute gives a two-year course in civil engineering to the Ensigns who desire to join the Civil Engineer Corps.

ORDNANCE, in addition to the course in torpedoes and ordnance design given at Massachusette Institute of Technology and ordnance optics at Columbia, requires a course of ordnance ballistics at the University of Chicago, ordnance explosives at the University of Michigan, and ordnance metallurgy at Carnegie Institute of Technology.

By this comprehensive system of post-graduate instruction, the Navy can be sure that its commissioned personnel will contain a sufficient proportion of technical experts who are acquainted with the latest developments in all material of a modern fleet. But the Navy Department gains a great deal more by this program of post-graduate education than a group of officers highly skilled in certain technical activities; it is brought at once in contact with the numerous educational institutions of our country; it must acquaint itself with their many activities in order to insure that the Navy is fully utilizing their services. This contact broadens the whole outlook of the Navy, for, in attending these various universities, naval students learn more than the content of their particular course—they learn the latest methods of instruction and the newest systems of research; and they return to the service bringing this new mental contribution with them which they gradually diffuse to the whole body of naval officers throughout the service.

ENSIGNS STUDY PARACHUTES

A class of Ensigns receiving post-graduate instruction in the use of parachutes

These technical specialists should insure us that our ships and their armor, guns, powder, shell, machinery, and boilers are the best that American science and industry can produce, and that the Navy will receive the care necessary to its efficient maintenance. This is an essential factor but it is not enough; the junior officers of the Navy will in due time succeed to higher command and they must early prepare themselves for this duty. To assist them in their preparation for their executive and operating duties, a "School of the Line," which was recommended in 1919, was established in 1927, as soon as the number of officers available permitted. This course embraces navigation, tactics (elementary), ordnance, mechanical engineering, electricity, logic, economics, diplomatic history and foreign relations of the United States, communications, radio, and aviation theory —a truly formidable list of subjects.

BUT it must be remembered that the young officers taking this course come from the fleet and have some knowledge of all these subjects and are likely to be thoroughly familiar with at least one of them. This course enables young officers to even up their progress in the various branches of naval science, while it requires them all to take such subjects as logic, economics, and diplomatic history, that will enlarge their mental horizon.

This School of the Line is an intermediate course between the Junior War College Course and the Naval Academy; and when practicable, graduates of this school, which lasts one year, proceed to the War College and, after taking the Junior Course there, are returned to the Fleet. This school, which the Navy established in 1927, completes the last link in the chain between the Naval Academy and the Naval War College. Junior officers fortunate enough to be assigned there, begin the study of the art of command which they will continue many years later—after much practical experience in active service at sea—by taking the Senior War College Course.

Aviation has become an integral and essential part of the Navy, and the Naval Academy curriculum has been widened to include many of its phases in the undergraduate work of the midshipmen. The Departments of Engineering and of Seamanship carry out most of the undergraduate work; and so important has it become that the junior class at Annapolis does not take the summer practice cruise but remains at the Naval Academy where it takes a three-months' course in naval aviation which includes aeronautical engineering, indoctrinal flights, and ground school work. Midshipmen usually average an hour's flight every second working day during this course.

In addition, the department maintains elementary aviation schools at Hampton Roads and San Diego for post-graduate work, where graduates may review their work of the Naval Academy, or, if they graduated before the course was established, can get an indoctrinal flight course and some ground school work.

The real Post-graduate Aviation School is at Pensacola, where naval aviators who are going to devote their major time to aviation receive either a primary or advanced course that requires two years.

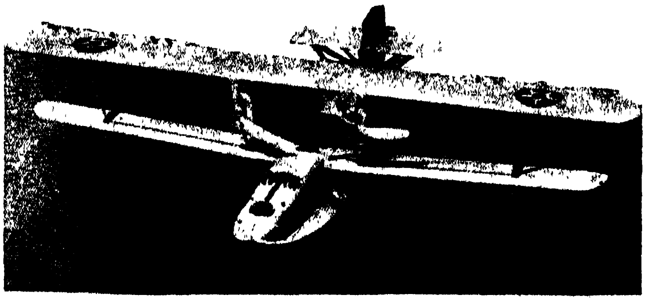
No less important than the Aviation School is the Submarine School at New London, Connecticut, where officers and men destined for the submarine service are given a six-months' course in the operation and care of submarines.

The Department also sends officers to the Chemical Warfare School of the Army at Edgewood, New Jersey, provides special courses in naval communications and torpedoes and gives refresher courses in languages to officers about to go to foreign shore duty.

The office of the Judge Advocate General in 1911 commenced sending officers detailed to duty there to the Georgetown School of Law after their regular office hours, and this practice continues.

THE predominating characteristic of the whole scheme of naval education is the preparation of officers for particular tasks, beginning at the Naval Academy where all available time and the energies of the officers and instructors are concentrated on preparing the midshipmen for their duties as junior officers of the Navy. The next step in the school system prepares line and staff officers for duty as heads of departments or command of small units, and in the third step, the Senior Class at the Naval War College, officers are prepared for high command after much practical experience.

The Naval Academy has a definite task to perform within a limited period of time, and although it gets splendid young material to develop, it must limit its effort and its course to the practicable, and must first make a midshipman a "capable mariner" and then add the "liberal education." The graduate of the Academy, no matter whether he goes into the Line or Staff, has only commenced his education. During his career he will probably learn more from the counsel, admonition, and criticism of his seniors, and from his own experience, than from text-books and formal courses. In training enlisted men, the young officer will begin really to educate himself, and as he matures he will find already in operation available for his use the comprehensive school system herein described. And what is more important, he will find in the service an appreciation of the necessity of post-graduate education that did not always exist. But the Navy properly and justly retains a healthy distrust of impractical theorists, and the final test of all officers will be their ability to carry on their work in the Fleet.



MIDSHIPMEN ALOFT

The Naval Academy keeps step with the development of naval aviation material

Canada's Peerless Playground

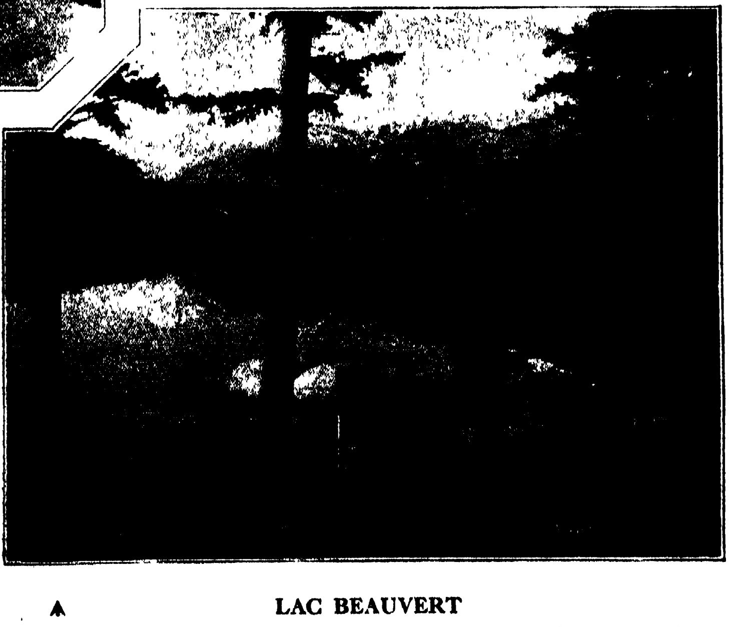
OUR own national parks are exploited to such an extent that we are apt to forget that our neighbor over the border also has the beauty of nature. Therefore we shall both illustrate and briefly describe the finest of Canada's natural possessions—Jasper Park. The avowed purpose of national parks is to make "the wild places of the land sacred." Civilization spells death to beauty; the primeval forest falls never to rise again. Waterfalls are denuded of their water so that wheels may turn and we can have cheap light and power. All these things are desirable, but the price is frightful. With the building of the transcontinental railways across the Yellowhead Pass a new door was opened to the Canadian Rockies; a new and wonderful alpine district was visioned to all lovers of the beauties of nature. Jasper National Park comprises 5380 square miles—a region larger than some European kingdoms, and more than half the total area set aside in Canada's national reserves. One of the chief characteristics of the park is the variety and beauty of its mountain lakes. Outstanding, too, are the number and depth of the canyons, each with its turbulent stream and often a fine waterfall thrown in for good measure.

ATHABASKA FALLS

The mountain in the distance is Mount Kerkeslin, 9900 feet in height. The water is milky with silt from many of the glaciers. Delicate touches of vegetation here and there save the rugged scene from apparent harshness

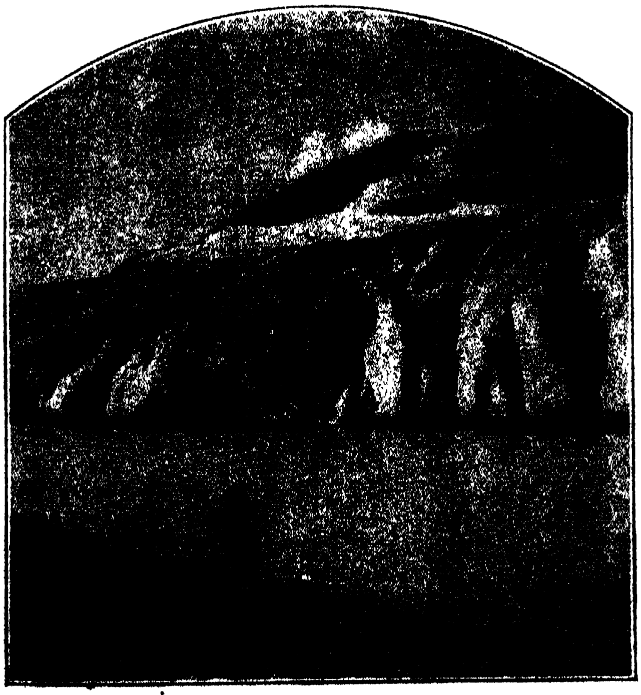
JASPER PARK GOLF COURSE

This golf course is interesting owing to the rocky character of the site. Hundreds of cars of earth were brought in from the prairies to provide the soil for the fairways and greens



▲ LAC BEAUVERT

Mount Edith Cavell is in the distance. A fine hotel has been built on the pine-girt shores of Lac Beauvert, one of the most beautiful lakes in Jasper National Park. The lake and the mountains form a surpassingly beautiful picture never to be forgotten by the tourist

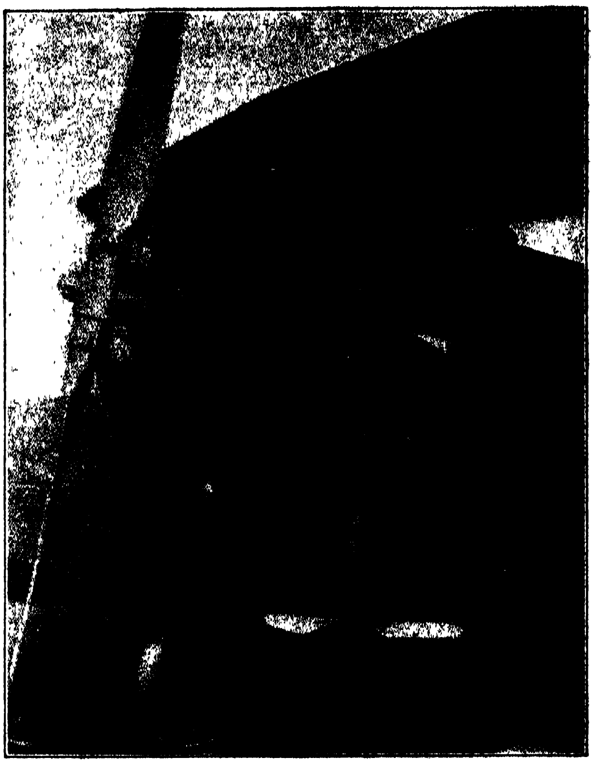


◄ GLACIER LAKE

From this vast ice sea issue streams which take their way finally to three oceans and carry life and fertility to thousands of miles of valley and plain. The attractions of Jasper National Park are so very diversified that it may be visited at any or all seasons of the year

The Successful Airplane Diesel

First Detailed Description to be Published of the Design of This Revolutionary Engine



THE PACKARD DIESEL ENGINE

In one of the test planes. In appearance, it does not differ radically from the conventional gasoline engine

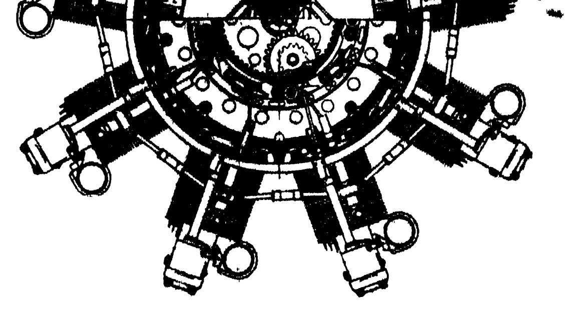
FOR several years much experiment and research has been carried out in the effort to adapt the Diesel engine to airplane use. About a year ago the Packard Automobile Company, of Detroit, announced that it had been successful in designing and building such an engine but the construction details of this engine have been a carefully guarded secret. In the meantime a very extensive testing program has been carried out, a close estimate showing that the total of experimental ground and flight testing of this engine has amounted to an equivalent of approximately 330,000 horsepower-hours which represents a sufficient output for an average plane to fly a distance of a quarter of a million miles. It has passed an Army 50-hour acceptance test, and for it the United States Department of Commerce has issued an approved type certificate. Its advantages have been covered in some detail in past issues of SCIENTIFIC AMERICAN*. In this discussion, therefore, we shall limit ourselves to a description of the most important constructional details, condensed from a description by the designer, Captain L. M. Woolson.

THE Packard Diesel aircraft engine is of the radial air-cooled type having nine cylinders with a bore of 4 13/16 inches and a stroke of 6 inches, giving a displacement of approximately 980 cubic inches. It is rated at 225 horsepower at 1900 revolutions per minute and weighs 510 pounds, or 2.26 pounds per rated horsepower. The engine's outside diameter is slightly over 45 inches and it is attached to the mounting ring with eight 3/8-inch bolts. So far as its general characteristics are concerned, with relation to size, weight, and general arrangement, the engine does not differ radically from conventional gasoline aircraft engines of a similar type. However, the engine incorporates many constructional features never before employed in aircraft engines.

A casual inspection reveals a radical departure from current practice in that each cylinder is supplied with only one valve which serves as both inlet and exhaust; and the single rocker-arm box which is slanted in the direction of the spiral of the slipstream contributes much to the clean external appearance of the engine and, what is more important, to its low parasitic drag.

The real point of departure between the system used by the gasoline aircraft engine and the Diesel engine are the ignition systems involved. The gasoline engine requires a complicated electrical ignition system in order to fire the combustible mixture whereas the Diesel engine generates its own heat to start combustion by means of highly compressed air. The temperature of the air in the cylinder at the end of the compression stroke of a Diesel engine operating with a compression ratio of about 16 to 1 is approximately 1000 degrees, Fahrenheit, which is far above the spontaneous ignition temperature of the fuel used.

One important advance, in the Packard Diesel, over previous Diesel practice, is the ability to extend the range of engine speeds possible with the Diesel cycle. Stationary and marine Diesels have heretofore been rated at 100 to 300 revolutions per minute and even so-called high-speed Diesels have been limited to about 1200 revolutions per minute. The speed of the Packard Diesel, however, has been increased to over 2000 revolutions per minute. This has been accomplished by an engine design that produces exceptional fuel turbulence. This and the highly efficient, quick-acting fuel pumps are the means that produce the accelerated mingling of the fuel and air which bring about the greatly increased speed. The engine structure has been designed to withstand the resulting maximum cylinder pressures which are considerably in excess of 1200 pounds per square inch.



IN PARTIAL CROSS-SECTION

Valves, cams, fuel system, and other parts described in the text are clearly shown

HERETOFORE Diesel engines, even of the lightweight type, have weighed about 25 pounds per horsepower; the Packard engine weighs but one tenth as much. A review of the design will show that important weight economies have been secured by the elimination of carbureters and magnetos and by an intense simplification of design. Evidences of the latter are found in the one-piece crankcase construction of extremely light weight and the single valve arrangement which automatically halves the number of parts ordinarily required for valve operation.

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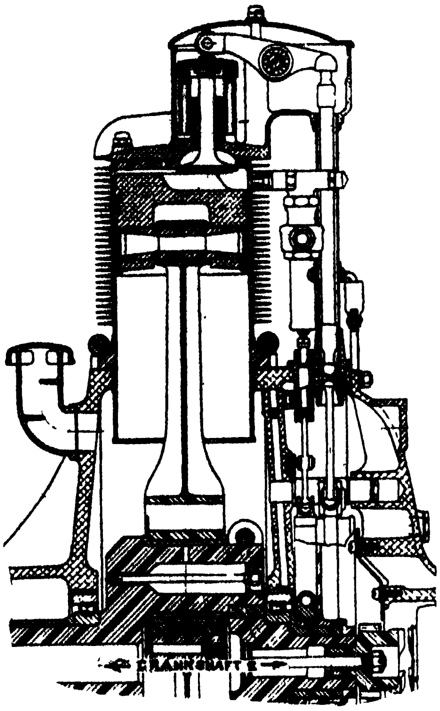
*See page 73, January, 1929; page 356, April, 1929; page 222, October, 1929; page 36, January, 1930; and page 310, April, 1930.

The crankcase, which weighs only 34 pounds, is unique not only because it is of one piece and thus dispenses with heavy flanges and bolts, but also in respect to the novel fashion in which the cylinders are fastened to the crankcase. Two circular hoops of alloy steel encircle the cylinder flanges in contact with the crankcase at the front and rear of the engine and these hoops are contracted by means of sturdy turnbuckles. Thus an initial stress which exceeds by a wide margin the operating stress resulting from the cylinder explosions, is set up in these hoops. Under this system the crankcase is subjected to an initial compression which it is well adapted to resist. When the engine is running, however, these stresses are materially reduced and at no time is it possible to transfer any tension loads from the cylinder to the crankcase.

Of no less importance are the arrangements whereby the crankshaft and propeller are protected from excessively high stresses. In the Packard Diesel the maximum cylinder pressures are over 10 times as great as the average cylinder pressures during the working stroke. This would necessitate the pistons, connecting rods, crankshaft and propeller being approximately 10 times as strong as they would have to be to resist the average pressure, were it not for the fact that effective measures have been taken to cushion these major parts of the engine from the shock loading. Advantage is taken of the fact that the peak explosion pressures exist for a very short time in each cycle. The crankshaft counterweights and the propeller are both flexibly mounted on the crankshaft so that the stresses in the crankshaft are greatly reduced.

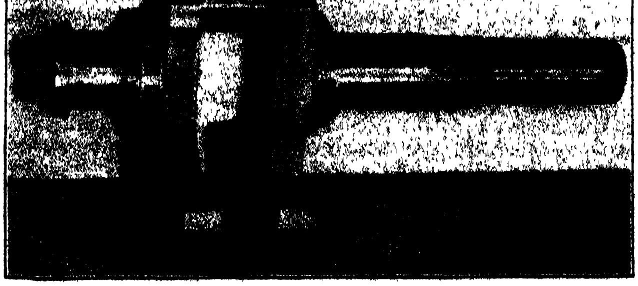
The counterweights, instead of being rigidly bolted to the cheeks, are pivoted on them and are located between powerful compression springs. When the crankshaft is suddenly accelerated, the counterweights lag behind slightly so that the peak cylinder pressure is expended before the counterweights are again solidly driven by the crankshaft. In a similar fashion the propeller hub is allowed to float on an extension of the crankshaft driving end, and specially designed propeller-blade clamp rings, provided with integral driving lugs, receive the driving effort from a two-arm driving member splined to the crankshaft. On the extremity of each of these two arms a pair of rubber blocks are compressed, between which the propeller clamp ring driving lug is secured. The inherent damping or hysteresis of the rubber blocks, supplemented by the surface friction in the counterweight mounting, quickly and entirely smooths out the shaft rotation.

Each cylinder weighs only 11¾ pounds. It was recognized that the cooling problem of a Diesel cylinder was considerably simpler than that of a corresponding gasoline engine cylinder since the increased thermal efficiency of the Diesel is reflected in far lower heat losses to the cylinder walls. This fact justified a simple form of closed-end cylinder design in which the cylinder head proper is formed integral with the cylinder barrel, a construction which is not considered satisfactory for gasoline engines.



CYLINDER CROSS-SECTION

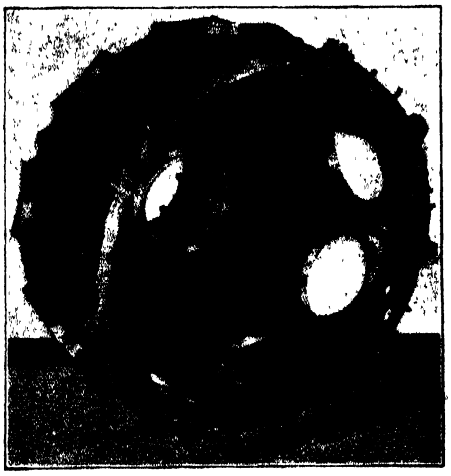
Side view, showing mechanism of one cylinder, left side, and the two cams



SHOCK-ABSORBING CRANKSHAFT

Here will be seen the method of mounting the counterweights on pivots between springs to cushion the shock of explosion

The fact that only pure air is drawn into the cylinder on the intake stroke of the Diesel permits the use of a single valve for both inlet and exhaust purposes. This arrangement makes for simplicity, weight saving, and reliability; and, furthermore, the available time for opening and closing the valve is lengthened appreciably so that lower rates of acceleration thereof can be utilized, thus saving wear and tear on the whole mechanism.



THE 34-POUND CRANKCASE

This is unique because of its construction and method of attaching cylinders

In this Diesel the turbulence necessary to insure a homogeneous mixture of fuel and air is accomplished by giving the incoming air an extremely rapid whirling motion. This high velocity spiral motion of the air is brought about by shaping the inlet port as a flattened Venturi arranged tangentially to the cylinder bore. By this method of air injection and the finely atomized injection of the fuel, accurately controlled and timed, complete combustion is assured.

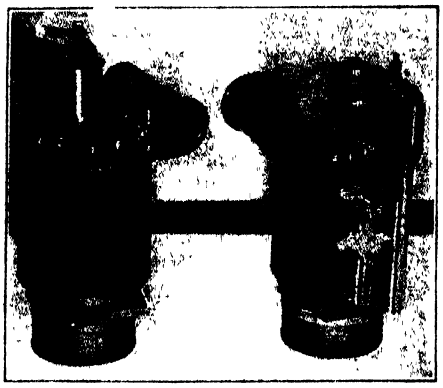
The feature which probably contributes most to this phase of operation is the combination fuel pump and nozzle unit. Heretofore the majority of solid fuel injection Diesels of the high-speed type have been characterized by a multiple pump unit mounted somewhere on the engine remote from the cylinder heads in which the nozzles are located, and connected to them by comparatively long capillary tubing. The many difficulties arising from this kind of system have been overcome in the Packard Diesel since the pump and nozzle are practically one unit with extremely short connecting passages between them.

The crankcase is a one piece magnesium alloy casting of rather large diameter, this casting supporting through the medium of a forged steel container a deep-groove ball bearing at the front end adapted to take both propeller thrusts and radial load at this point. A roller bearing is mounted immediately ahead of the front crankshaft cheek, this bearing arrangement being quite orthodox.

The crankshaft is of the commonly used split type, the rear half being attached to the front half by means of a clamp bolt and key engaging the crankpin. The rear crankshaft bearing is also of the roller bearing type and is supported in a removable wall in the crankcase, termed the diaphragm. The diaphragm also carries the major working parts concerned with the operation of the valves and fuel pumps.

The connecting rod assembly follows standard practice in practically every respect, a master connecting rod being used in conjunction with eight link connecting rods.

The valve and fuel-pump push rods, of which there are nine each, are radially arranged at the rear of the engine and are, in turn, operated by two cams which are formed integrally and each of which is provided with four lobes. These cams are driven at one-eighth engine speed in the direction opposite to the crankshaft rotation, a large internal gear being formed integrally with the cams and a compound idler gear meshing with the cam and crankshaft gears respectively. Both the single valve and fuel pump of each cylinder are operated through the medium of rocker arms which contact with the respective cams and are supported on a common shaft which is anchored in the diaphragm and which also obtains a steady bearing in suitable bosses formed in the cover casting.


LIGHT-WEIGHT CYLINDER

At left: front of cylinder with air intake.
At right: rear, air valve and fuel pump

WHEREAS the inner end of the air-valve push rod seats in a spherical receptacle formed in the rocker arm referred to, the inner end of the fuel-pump operating push rod fits in a specially formed groove or channel provided in the fuel rocker arm. Furthermore, these fuel-pump push rods are connected by linkage near their inner ends to a circular control ring mounted in a groove on the diaphragm, the movement of which ring is controlled by an externally mounted lever connected to the pilot's control and *offering the sole means of regulating the speed of the engine.* The linkage referred to moves the inner end of the pump push rods, this movement altering the effective stroke of the fuel-pump plunger and thus varying the amount of fuel injected into the cylinders in accordance with requirements.

The cylinder-head caps (see drawings) are light aluminum alloy castings which serve merely to support the overhead valve mechanism and valve stem guide and incorporate the inlet and exhaust ports. This casting is secured to the top of the cylinder by means of ten studs which insure good thermal contact for heat transfer from the upper surface of the cylinder to the radiating fins on the caps.

The aluminum alloy piston used is characterized by a peculiarly shaped head provided with an eccentrically located pocket which is designed to promote, in conjunction with the inlet port and valve arrangement, the high degree of turbulence which is so largely responsible for the efficient operation of this engine at high speed.

The fuel pump and nozzle assembly constitutes a radial detachable and interchangeable unit which is bolted to a flange on the rear of each cylinder. Among the advantages favoring this construction are the elimination of all high-pressure tubing between pump and nozzle and the avoidance of the resultant troubles, such as air pockets, after dripping, and variations in timing due to the compressibility of the liquid in the piping and the elasticity of the pipe itself under pressures as high as 6000 pounds per square inch.

ONE of the major problems in connection with the development of this Diesel airplane engine has been the matter of starting. The special requirements in aircraft service are that the engine must start promptly in all conceivable operating temperatures, and also that the starting mechanism must be light in weight and simple to operate. A great deal of experimentation was carried on with various types of starters, such as the cartridge type using 12-gage shotgun shells, the compressed air type, and various forms of field starters not carried in the plane. It was finally concluded that the conventional type of inertia starter, used so extensively with gasoline aircraft engines, offered the best solution. It was also found necessary to develop an incandescent heating element, or glow plug, to give the required heat for starting at below-zero temperatures. These glow plugs offer no handicap to the ordinary operation of the Diesel. With them instantaneous starts are possible at any temperature at which it is possible to turn the engine over at all.

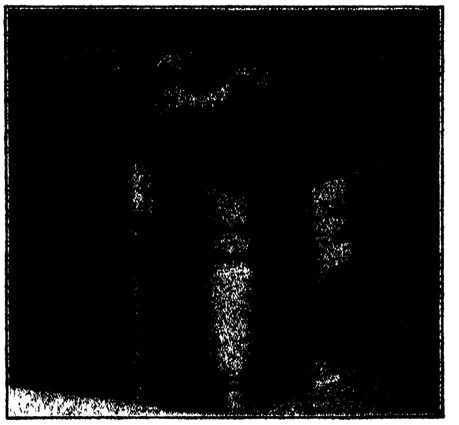
The starter incorporates a small flywheel which is rotated through a system of gearing at very high speed by means of either a hand crank or an electric motor. When sufficient energy has been imparted to the flywheel, a dog-type clutch is manually engaged with the crankshaft, resulting in the rapid cranking of the engine during the few seconds necessary to dissipate the energy stored up in the flywheel. The engine starts immediately on its regular supply of fuel oil, no special fuel or preparatory heating being necessary. At very low temperatures, however, it is essential to use the glow plugs.

In stopping the engine it is merely necessary to close the throttle completely against a spring stop, this extra motion of the throttle mechanism serving to restrict the stroke of the fuel pumps so that no fuel is forced into the nozzle. The engine can be stopped instantly no matter how hot it may be, without danger of kicking backwards.

SUMMING up: the engine is started with the throttle wide open, and then is easily stopped by closing the throttle completely. There are no other controls used except those of the inertia starter. The engine automatically adjusts itself to burn efficiently whatever fuel is being injected.

A very intensive testing program was carried out in the development of the Packard Diesel. This testing has comprised dynamometer, torque stand, and flight testing in two different types of planes: a Stinson Detroiter, six-place cabin plane, and a Waco three-place open cockpit plane. Ground testing on individual engines has been carried up to 500 hours on the dynamometer. This program has covered a period of two and a half years of test work.

As a result of this development, simplification and further economies in the operation of transport planes may be prophesied. Large transport, mail, and freight planes may be driven either by a single Diesel engine of large power or possibly by two smaller engines mounted on the wings so as to remove the source of noise from the passenger compartment. In this fashion it is believed that a high degree of safety and low cost of operation will be arrived at, thus greatly stimulating the growth of commercial aviation.


ALUMINUM ALLOY PISTON

With two compression rings and one oil ring. The pocket helps promote turbulence

Advice to Students of Aviation*

By DR. H. J. COOPER

Medical Section, Aeronautics Branch, Department of Commerce

ALL persons desiring to become licensed pilots should bear in mind that while they may pass the physical requirements for student and private pilot licenses, that is no guarantee they will not have difficulty with the physical examinations for limited commercial or transport licenses.

Many former students have been physically disqualified when they applied for limited commercial or transport licenses, and, as a result, considerable misunderstanding and disappointment have arisen. Therefore, the medical section of the Aeronautics Branch desires at this time to disseminate as much information on the subject as possible.

THE medical section approves or disapproves a medical examination upon the basis of the grade of license applied for. If a student examination shows that the applicant just barely meets the physical requirements for that grade, he will be qualified for it. However, the medical section can not write the applicant that while he has been approved as a student pilot, and will be approved later for the grade of private pilot, his examination is unsatisfactory for either limited commercial or transport pilot and therefore he will not be able to reach either of these grades of license as long as his present defects exist.

The reason the medical section can not do this is because it has no way of knowing, out of the total number of student applications received, what students plan to become limited commercial or transport pilots.

There are two fundamental principles that a student should keep in mind when he starts in training.

1. If his sole desire is to become a private pilot for the purpose of flying his own plane when and where he pleases, and if he has no desire to operate commercially, he should take the student physical examination. If satisfactory, this examination will also qualify him for the grade of private pilot when he becomes eligible for the flight test and the written examination for that grade.

2. If a student's sole purpose in applying for a student permit is to become later a limited commercial or transport pilot, he should take the transport physical examination at the start. In this way he will know before he starts his training whether he has any defects which will bar him from qualifying for that grade of license he ultimately desires.

The student who desires to become a limited commercial or transport pilot will not be put to any more expense for medical examinations by following this advice, because, although he pays $15 for the transport examination, this examination includes tests that will not have to be made again no matter how long the interval may be between the date of the examination and the time at which he becomes eligible for the limited commercial or transport license. If he takes the student examination for $10, he will later pay $5 for that portion of the examination not made originally.

The attention of student applicants also is directed to the following:

1. The Department of Commerce maintains two types of physical examination, one for student and private pilot and one for limited commercial and transport pilot. The requirements for student and private pilot are, of course, very much more lenient than those for limited commercial or transport pilot.

2. Any applicant who has been physically qualified for student pilot on the basis of a satisfactory student examination will be physically acceptable for private pilot at a later date, provided, of course, that his physical condition has not changed adversely in the meantime.

3. Any applicant who has been physically qualified for student pilot on the basis of his having taken and passed a transport physical examination, will be physically acceptable for any grade of license applied for at a later date, again provided that his physical condition has not fallen below standard in the meantime.

4. When a student applicant takes the transport physical examination and finds that while he qualifies for student and private pilot, he does not qualify for limited commercial and transport pilot, he should write the Medical Section, Aeronautics Branch, Department of Commerce, Washington, for an official opinion on his defects. The Medical Section will inform him what the possibilities are of his receiving medical approval for the higher grades of license by a waiver.

5. If any applicant is physically disqualified for student pilot, he is at liberty to inquire of the Department the nature of his defects, and if the medical section believes there is anything in the way of treatment that will reasonably improve the defect, the applicant will be so advised.

6. When a student applicant has been physically disqualified by a medical examiner, he should await action on his examination by the Department. He should not visit other examiners in an effort to qualify, for even if an examination made by another medical examiner is satisfactory, it will not be accepted. Under such circumstances the Medical Section will require that the applicant return to the original medical examiner in order to demonstrate to that examiner that the disqualifying features are no longer present.

7. Prospective applicants who know they have certain physical defects are invited to communicate with the Medical Section and state the nature of the defects. The Medical Section will inform the prospective applicant whether or not the defects are disqualifying.

8. The student permit of any student will be suspended in case of an accident in which he sustains personal injuries such as to interfere materially with bodily functions. The suspension of the student permit will be maintained until the student is able to submit to a physical examination, made by an authorized medical examiner, showing that the student has recovered from his injury. In case of partial recovery, the medical section will determine whether or not the recovery is sufficient to warrant removal of the suspension.

9. In order to make the visual requirements clear, special attention is directed to this paragraph. The lowest vision acceptable for student pilot is 20/50 in either or both eyes, without correcting lenses. Judgment of distance must be within the normal specified limits, without correcting lenses. If the student just meets the foregoing minimum requirements, he is required to wear correcting lenses in his goggles, bringing his vision approximately to normal. His judgment of distance must be within qualifying limits while wearing this correction. Failure to meet any of the foregoing requirements will result in disqualification.

10. When it is necessary for the student to wear corrective lenses in his goggles, the correction should be ground into the goggle lenses. Small corrective lenses fastened on the inside of the ordinary goggle should not be purchased. Students should be very particular in these matters, for incorrect lenses often result in harm to the vision.

11. Student applicants who do not meet at least the minimum physical requirements will not be recommended for license. Waivers will not be recommended for students.

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Stunting for Safety

Training in Plane Acrobatics Instills Confidence and May Help the Pilot Out of Tight Places

By LIEUTENANT (j.g.) H. B. MILLER, U. S. N.

STUNT flying has been the direct cause of perhaps more peacetime air crashes than any other one thing. As a result of this fact and the consequent adverse publicity freely dispensed by many periodicals and newspapers, the prejudice of the public against stunting has been so encouraged that it is now almost insurmountable. The ability to stunt, however, is at times an invaluable aid to safety; it may even mean the difference between life and death for the pilot and his passengers. Lieutenant Miller explains in no uncertain terms why and when this is so.

—The Editor.

IN A SWEEPING DIVE

A Boeing Navy fighter in a dive. It is imperative that all military aviators have much stunt flying training

THE reaction of the public against stunt flying has definitely begun. Denunciations of stunting and acrobatic flying are becoming more and more frequent. No doubt there has been sufficient flagrant display of this type of flying to warrant public censure, but on the other hand, it is more likely that the whole truth of these cases has not been known.

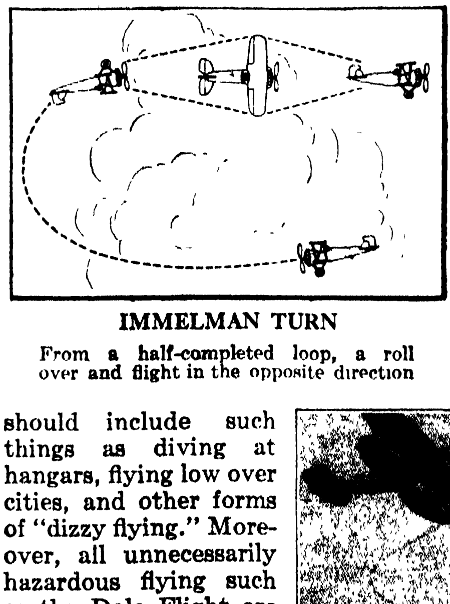
Only recently a pilot lost control of his plane while performing a loop. Both the pilot and passengers were killed. Moreover, people on the ground were endangered, because the plane fell into the heart of the residential section of the city. On the face of the matter, stunt flying would automatically be condemned.

UNFORTUNATE as is this case, it is positive proof of the definite need of thorough acrobatic training for all flyers. This particular pilot had just obtained his private license, after the necessary 15 hours of solo flying and 10 hours of dual instruction, which permitted no time to devote to advanced flying. The pilot's stunt training was obtained on the ground at a round-table discussion. In addition, the flyer violated all air traffic rules when he stunted over an inhabited district. It is amazing to think that two people could be found who had sufficient confidence in such a novice pilot as to take a joy hop with him.

Had the pilot qualified after a thorough training course, he would not have lost control of his ship. Also had he been thoroughly indoctrinated, he would have observed the Air Commerce Regulations and private property would not have been endangered.

For safety's sake, then, why not prohibit all forms of stunting by all pilots? The answer is a paradox. For safety's sake, regulated acrobatic flying should be encouraged.

The expression "stunt flying" is used generally to cover the abnormal maneuvers which can be done with an airplane. In addition, this expression should include such things as diving at hangars, flying low over cities, and other forms of "dizzy flying." Moreover, all unnecessarily hazardous flying such as the Dole Flight are covered by the term "stunt flying."



IMMELMAN TURN

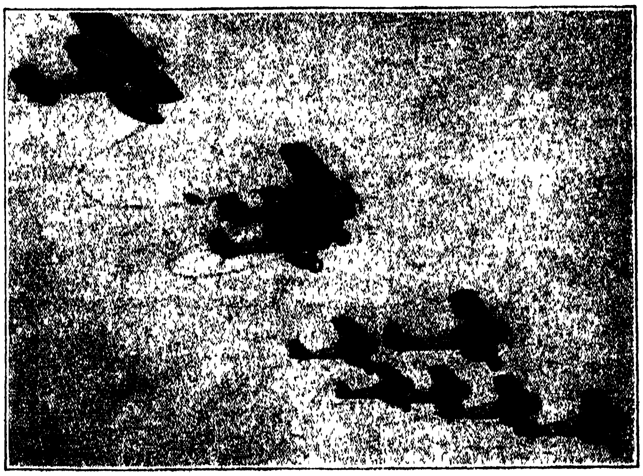
From a half-completed loop, a roll over and flight in the opposite direction

Such stunt flying as changing from one plane to another while in flight, and long over-water flights in land-planes after insufficient preparation, add nothing to the progress of aviation. Failures resulting from such attempts discourage the enthusiasm of the public for aviation.

Our military services will not assist in the dedication of an airport, when the program tolerates such flying as wing-walking. This type of stunting is discouraged officially.

The expression "acrobatic flying" is accurately applied to those intentional maneuvers of a plane flying in any positions other than a straight line. When done at a dangerously low altitude, acrobatic flying becomes stunt flying.

Acrobatics can be indulged in safely only with suitable equipment. Training ships and sport planes capable of being stunted are now available. Strength sufficient for violent flying is built into these ships and the manufacturer of a plane will state the maneuvers for which his ship is designed. The pilot who stunts a plane which is not designed for that purpose will sooner or later come to grief. Too often have the wings deserted an old broken-down plane during some violent maneuever. The flyer who recognizes the limitations of his ship will probably enjoy a long career in aviation.

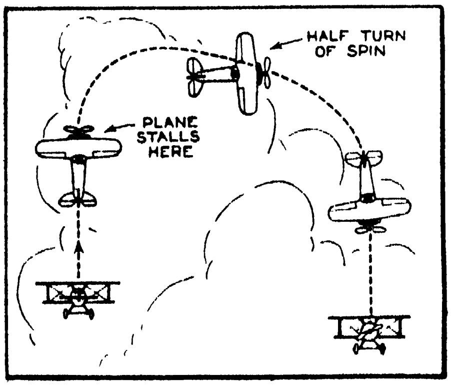


All photographs are Navy Official

THE HIGH-HAT SQUADRON

Executing difficult maneuvers and formation flying with planes lashed together with ropes, at the National Air Races

Acrobatics can be performed with various degrees of gentleness. Some pilots can bring a plane down after a stunt hop with the ship in perfect condition. Others will perform exactly the same maneuvers and land the plane with slack in the brace-wires. Few ships have ever been built that cannot be broken up in the air if the pilot so desires. Even military fighting planes, which possess a safety factor of 12, can be flown to pieces. Just because a commercial plane will withstand active evolutions, that feature should not be abused. Material failures are especially apt to result when pulling out of prolonged and fast dives.



SPLIT "S"

Useful for turning in a limited space. The pilot climbs steeply, stalls, and turns

Confidence can be instilled in a student flyer in no better way than by giving him acrobatic training. This should come after the student has had 15 or 20 hours of solo flying. A person learning to swim progresses slowly until he is thoroughly at home in the water. Moreover, he lacks faith in himself at first. The same is true of the student aviator.

Handling a plane under unusual conditions and attitudes gives the young flyer complete confidence in his flying ability. If he should ever find himself thrown into some unusual maneuver, it will not be strange to him. He will instinctively manipulate his controls as in acrobatic flying in order to return the plane to its normal attitude.

One case on record shows that a flyer became lost in a low-hanging fog. In endeavoring to continue his flight to a landing field, he followed a blind canyon. Suddenly the pilot found himself hemmed in by the canyon walls. In front was a spur of the mountain which was too high for him to climb by flying straight ahead. Nosing the plane down momentarily to gain speed, the pilot pulled back sharply on his control stick. At the top of the loop, he half-rolled his ship into an Immelman turn. Saved; one life!

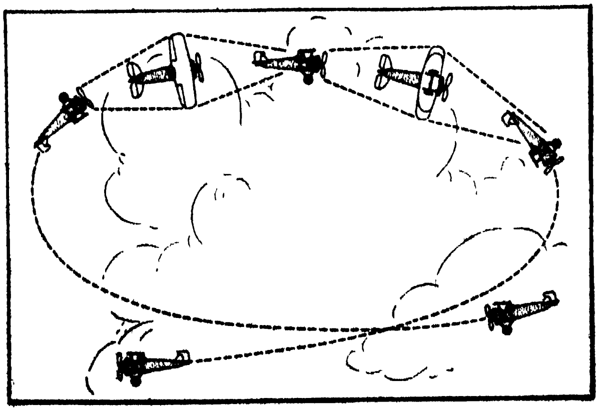
Instructions in acrobatics are quite simple. The various stunts are discussed in detail on the ground. The instructor then takes the student up and goes through each maneuver a number of times. With the instructor still in the plane, the student goes through the evolutions until he has learned to perform them with a fair degree of skill. The novice then must put in many long hours of solo acrobatic flying for mastery of stunts is had only by long and arduous practice. Finesse and perfection are a result of hard work.

LOOPING IN FORMATION

An experienced pilot can follow another through any maneuver. Here three Navy planes are on top of a loop

EXCLUDING the various forms of inverted flight, which is extremely advanced, there are only a comparatively few acrobatics. By ingenious combinations, a skilled pilot can appear to do a multitude of distinct maneuvers, but the bases of practically all of them are the loop and the spin. Nearly all other maneuvers are merely variations of the spin. Among these are the barrel-roll, which is a horizontal spin; the falling leaf, which is a series of partial spins, alternating to right and left; and a split "S" which is a half-spin reversing the direction of flight.

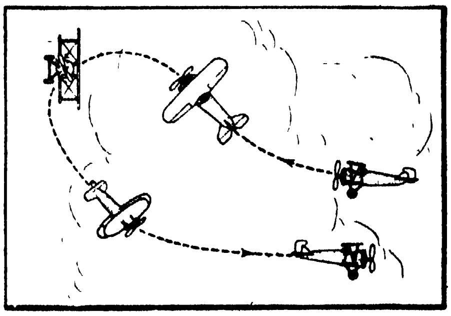
A combination of loop and spin produces a roll on top of a loop. The Immelman turn is merely a half-roll executed at the top of the loop. This reverses the direction of flight and at the same time gains altitude. The roll can be extended into a double-roll and even a triple-roll. A recently devised maneuver has proven popular. This is called the "slow roll." In this the pilot rolls his ship horizontally by use of the ailerons alone. An appreciable length of time is required for this maneuver, as compared to the snap-roll which is merely a stall.



A DIFFICULT LOOP

The pilot begins the loop, makes a full roll at the top of it, completes the loop, then continues original flight

The flipper turn and the wing-over are not classified as stunts. The former is merely a steep turn of a greater bank than 45 degrees. Here the action of the elevators and rudders reverse in their relation to the horizon. Picture the tail surfaces inclined over 45 degrees from their normal position. The rudder then becomes the elevator, and vice versa. The wing-over is merely a 180-degree turn with a sharp climb at the moment of greatest bank.



WING-OVER

A climb, a steep banking turn, and the plane has reversed, but has lost altitude

This maneuver begins with what is practically a stall and, when it is completed, the plane is flying in the opposite direction with less altitude.

Acrobatic flying is used by the military services almost exclusively for training purposes. A good stunt pilot is generally a smooth flyer. Always, is he master of his plane, but he rarely, if ever, indulges in acrobatic flying without good reason.

Contrary to popular belief, stunts are

DOING A BARREL ROLL

A Navy fighting plane doing a barrel roll, photographed past the rudder of another plane. This maneuver is the same as the ordinary spin, except that the plane's movement is horizontal

seldom indulged in during aerial combat. This is because most of them are based on a spin which is a result of a stall, and a stall means, of course, loss of speed and altitude—two factors which cannot be sacrificed during combat. It is an acknowledged fact in pursuit work that the simplest maneuvers will lead to a conservation of altitude and consequently to the most advantageous positions. An experienced pilot will follow his enemy through a loop or Immelman turn with no difficulty whatsoever. And if the enemy goes through maneuvers that result in loss of altitude, the following plane holds a distinct advantage.

"THREE SEA HAWKS"

From left to right, Lieutenants Davis, Tomlinson, and Storrs, three Navy fliers

The commercial flyer has no need for stunts in his everyday work. If he has mastered acrobatics, however, he will be a better flyer in every way. Safety in the air is augmented by the experience and skill of the pilot. The passengers he carries will be safer because of his ability to handle a plane in any emergency or abnormal attitude.

Except in a very few special cases, acrobatic flying should be indulged in only under the air-traffic rules of the Department of Commerce. The basis of these regulations is safety—for the performing plane, for other planes in the air, and for people on the ground. These rules provide that no acrobatic flying shall be done over a congested area, over an open-air assembly of people, or within 1000 feet horizontally from an airport or airway. These are very necessary rules.

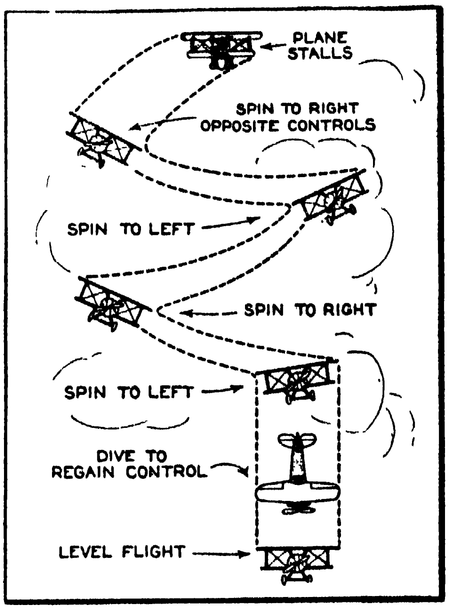
Further, all such maneuvers shall be completed at an altitude of not less than 1500 feet. This is a wise provision. The student, especially, needs plenty of altitude in order to recover from possible spins. High aloft, mistakes can be corrected, and in case of engine failure a bountiful supply of altitude is most comforting.

Exceptions to the Air Commerce Regulations are granted in special cases. For instance, at the National Air Races, acknowledged masters of acrobatics are permitted to perform at lower altitudes. As a crowd producer, there is no equal to such spectacular performances.

Who, having seen them, can forget the "Three Sea Hawks," and the "Three Musketeers" at the races held in Los Angeles in 1928? The tremendous crowds saw probably the most perfect flying of all time.

As the Sea Hawks rolled over and flew across the field on their backs in perfect formation, one man who was watching the performance was overheard to say, "I don't believe it. There is a trick in it somewhere." The trick was in the many hours of hard work these men had devoted to the attainment of perfection. They knew every trick of the air and of the planes they were piloting.

No one who saw Lieut. Al Williams' inverted stunt flying at the Air Races in Cleveland last October could fail to realize that here was a master of the airplane. His uncanny skill is a direct result of the many arduous hours spent in practicing acrobatic flying.

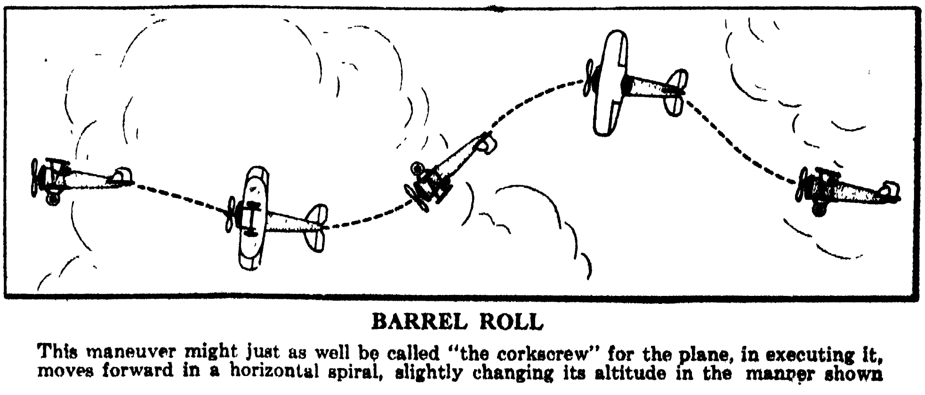


FALLING LEAF

After a stall, the plane settles like a leaf until the pilot dives to regain control

Fortunately, the Department of Commerce prohibits stunting with pay passengers. But there are thrill-seeking people who would tempt a pilot with money to attempt maneuvers unsafe with his type of plane. Accidents would multiply overnight if this restriction were removed. Few pilots can afford to fly a person on a stunt hop just for friendship's sake. It is an expensive gesture and, in addition, there is always the possibility of a resulting liability lawsuit if the passenger should be injured, friendship or no friendship.

Acrobatic flying is merely hard work which prepares a pilot to fill a position of responsibility and trust. It is therefore of the greatest importance that the syllabus of every aviation school should include thorough training in acrobatic flying.



BARREL ROLL

This maneuver might just as well be called "the corkscrew" for the plane, in executing it, moves forward in a horizontal spiral, slightly changing its altitude in the manner shown

Midget Marine Motors

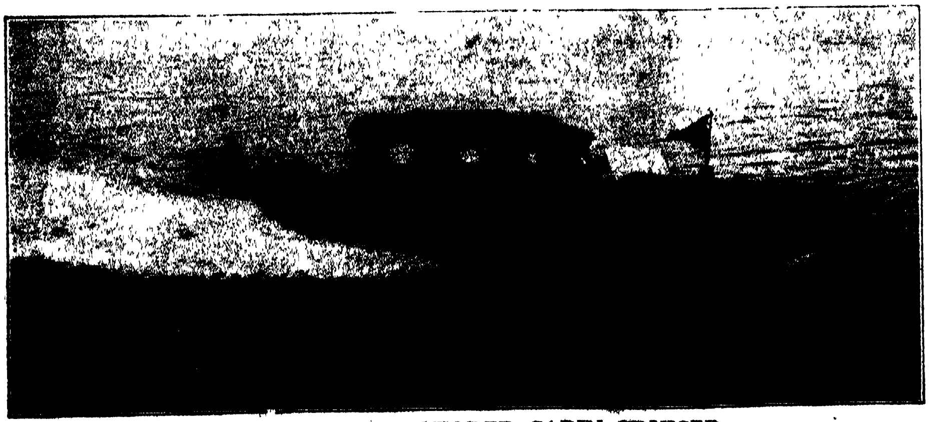
The Rise of the Outboards Has Been Rapid, But Even Greater Developments May Be in Store

By THOMAS W. FARNSWORTH

THE desire to transform the row boat into a motor boat was no doubt the *raison d'etre* of the outboard motor. The first attempts were simply small editions of larger inboard motors, with clutches, shafting, foundations, stuffing boxes, and struts. It was, of course, difficult to shift these from one boat to another, and even when this was done, the chances were that the new boat had to be made over before it would take the motor. The solution of this problem was a portable, detachable motor which could be clamped to the stern of the small boat. Thus we have the so-called "outboard motor."

ONE man's meat, as has been said, is another man's caviar. And how well we see this demonstrated in the world of outboard motors! The little motor which saves hours of labor for the fisherman or hunter who "putt-putts" to his day's sport in the early dawn, is the same motor which gives hours of joy to the children at the seashore or on the lake, while the more powerful motors provide the last word in thrills for those who get their fun in racing or stunting on the water.

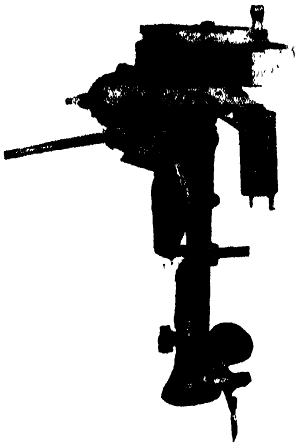
Formerly automobiles put a damper on pleasure boating, but now it would seem that they are helping to revive it. As automobiles increased in numbers and popularity, the demand decreased for power boats for recreational purposes. Boats, the usefulness of which was limited in most American climates, to approximately six months of the year, could not compete with the year-round automobiles, offered in about the same price range. But now that the highway congestion is becoming so tremendous, people in greater numbers each year are seeking recreation on the water. In many instances the automobiles are used simply to get to the boats, or perhaps to carry the boats to the water.



AN OUTBOARD MOTORED CABIN CRUISER

Motors can now be obtained that are adaptable to almost all kinds of craft, from tiny rowboats to such luxurious cruisers as the Sea Sled illustrated in the above photograph

Once the boating public made up its mind that it must have a portable motor—and hence one that was light and free from a multiplicity of parts—it was logical that the fundamental working principle should be that of the two-cycle system.



AN OLD TIMER

One of the first Evinrude motors ever produced. Compare with the new models

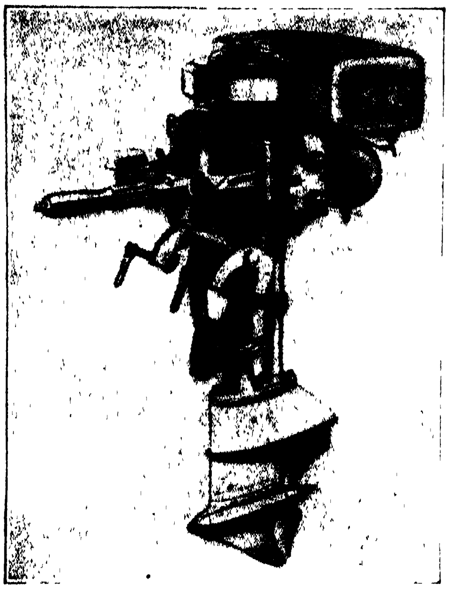
Briefly, a two-cycle motor consists of crankcase, crank, connecting rod, piston, and cylinder. It gets its name from the fact that in one revolution of the crank the two strokes of the piston complete the cycle. There is an explosion every time the piston reaches the top of the stroke, as against every other time in the four cycle.

THE AUTHOR AFLOAT

The first outboard motor in the United States (which country now leads the world in outboard motor production) was built by C. D. Waterman in Detroit, Michigan, in 1904. There is record of the Waterman Marine Motor Company's advertising outboard motors as long ago as 1908. The Waterman motors were produced by the Caille Motor Company. The first motor had a single cylinder, held vertical. The crank, which was horizontal, drove a vertical shaft through a set of bevel gears. This shaft followed down to below the water line where it drove the propeller through another set of bevel gears. Most of the working parts of this motor were exposed. The whole unit pivoted for steering. A long tiller handle extended into the boat and on this was attached a fuel tank.

ABOUT 1910, Ole Evinrude came into the field with an engine similar in form to the one which is in present use. This engine had its cylinder placed horizontally and the crank drove the shaft direct, thus eliminating a set of bevel gears. An attempt to eliminate the lower set of bevel gears was made by driving a shaft direct with a propeller on the end of it and supporting the whole unit at an angle on the transom of the boat. By 1914 there were no less than ten manufacturers in the outboard field.

Before 1920 outboard motors were composed largely of cast iron, malleable iron, and bronze. With the introduction of the Elto light twin in 1921, aluminum made its appearance, while shortly thereafter an aluminum alloy called Lynite, having approximately twice the strength of aluminum, was used extensively in the construction of outboard motors. Thus, today we have at one extreme a twin-cylinder motor weighing but 29 pounds and developing 2¾ horsepower, while at the other extreme is a 4-cylinder motor



"SEA HORSE 32"

A Johnson four-cylinder outboard, typical of design advances that have been made

weighing 120 pounds and developing 35 horsepower. This low weight per horsepower is due directly to the extensive use of alloys.

Before 1921 no attempt was made to streamline under-water parts. In 1921 and up to the present date, streamlining of the lower unit and gear housing has been a most important factor in the construction of the outboard motor. The airplane industry has contributed some valuable data in this connection.

IN 1921 Ole Evinrude, now president of the Outboard Motors Corporation, and the Johnson Motor Company brought out motors with twin cylinders opposed. In 1924, outboard motor boats were raced. An Elto twin averaged nine miles per hour. The next meet produced an Evinrude motor which made 12 miles per hour. From that time progress has been made by leaps and bounds until at the present time outboards on specially designed boats are approximating 50 miles an hour.

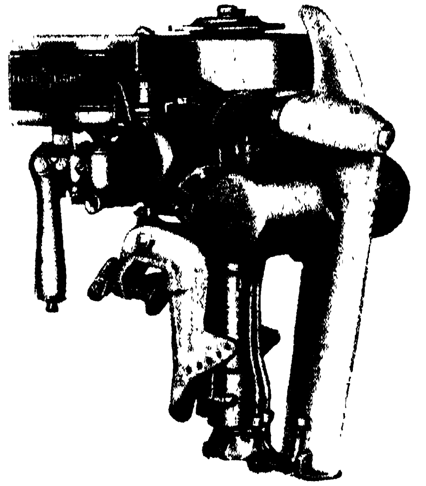
In 1928 the Elto Outboard Motor Company brought out the first four-cylinder outboard motor, and the Johnson Motor Company put an additional valve on their motor called a "release charger." This valve releases the compression in the inactive cylinder and diverts the entire charge of fresh gas to the active cylinder, making the motor much easier to start.

Here then we have motors which have not increased in weight in anything like the proportion of their increase in power. The refinements which have gone into the improvement of these motors are very interesting. The power curve, which began to drop off at 2600 r.p.m. had to keep going up to 5000 r.p.m. This necessitated handling the gas mixture faster, cutting down the resistance and balancing and lightening the moving parts. The new features, designs, and mechanical refinements which have been added to outboard motors have had to do largely with increased revolutions per minute. As most of us know, horsepower is in direct proportion to revolutions per minute. So if the 2000 r.p.m. motor of yesterday was four horsepower, the same motor at 3000 r.p.m. would be about six horsepower and at 4500 r.p.m. would be about nine horsepower— as we find it today.

THE friction and retardation of the gas being sucked into the crankcase, compressed, expanded into the cylinder, compressed, exploded, expended, and ejected by the fresh charge, had to be overcome. One way in which it was found that this could be done was to increase the number of ports, and last season saw two-port, three-port, and four-port motors. One motor came out with a combination of two and four ports, using a mechanically operated rotary valve to admit the gas mixture to the crankcase. This rotary valve not only permitted a large opening to the crankcase, but because of its mechanical operation kept this opening effective for the full length of the suction stroke. The same result is accomplished with a valve acting against a spring installed in the intake manifold leading to the crankcase. In this way, instead of the gas mixture being shot into the crankcase during the brief opening of the ports, it is sucked in continuously during the outward travel of the pistons. Larger openings, admitting gas for a longer time, mean a greater volume, higher compression, more revolutions per minute, and hence more power.

Compression has been increased by reducing the crankcase dimensions and when the limit was reached, the crank itself was increased in size to take up more room. Cylinder compression was increased in proportion by reducing the compression chamber. In the early racing days, motors were "pepped up" by filling in under the pistons with cork or Plastic Wood and brazing metal to the piston head.

Having satisfied in part the public's demand for speed, the manufacturers of outboard motors have been turning their attention to improvements and refinements. These include ease of starting, under-water exhaust, balanced reciprocating parts, ball- and roller-bearings, streamlined under-water parts, lighter and stronger materials, oiling and cooling systems, and so on.



Courtesy Outboard Motors Corporation

THE "FOLD-LIGHT" TWIN

An Elto motor especially designed for carrying in a motor car or otherwise where extreme light weight and compactness is desirable. Note two mufflers

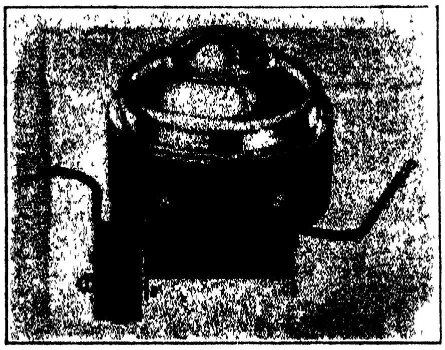
A recent addition to the outboard motor field is a product of the Indian Motor Cycle Company. This firm has had 27 years' experience in the building of small motors. Their

THE CAILLE "MULTI-FLEXIBLE" CONTROL

By moving the tiller arm up and down as at the left, the pitch of the propeller and consequently the speed of the boat may be varied. Also, as at the extreme right, the propeller blades are in "reverse" when handle is in position 5. Neutral position is obtained at 4 heavily finned one-piece muffler and under-water exhaust, one-piece crankcase, and new cylinder construction of hot-head type are outstanding features.

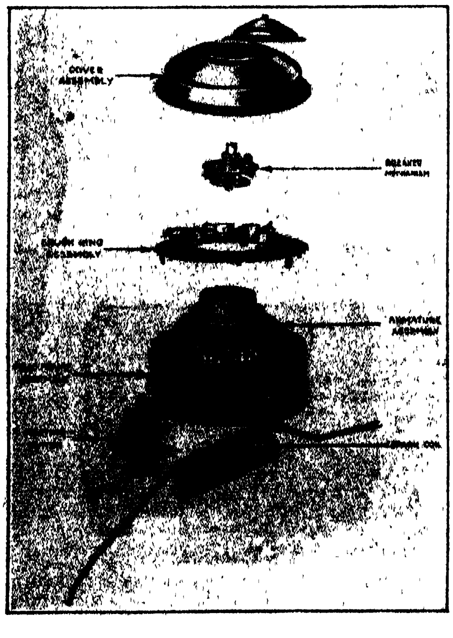
Because the two-cycle motor has simplicity, cheapness, compactness, inherent light weight, ability to run at any angle, ease of lubrication to a degree, lack of moving parts, and steady running, the disadvantages have been overlooked, even though these are rather numerous. We might list, for instance: hard starting, lack of low-speed control, temperamental control and operation, lack of thorough lubrication, concentration of heat about the exhaust ports, enormous fuel and oil consumption, uneven piston heat temperatures, spark plug difficulties, poor carburation because of low depression in the Venturi and bad fuel caused by oil being mixed with the gas.

When we consider this rather formidable-looking list there would seem to be little wonder that a four-cycle outboard motor is being attempted which does away with most of these disadvantages and contributes many additional advantages. The Cross radial five-cylinder motor, built by the Cross Gear and Engine Company of Detroit, is the outstanding example of efforts along this line. This motor is said to develop 50 horsepower at 4000 r.p.m.



ELECTRIC STARTER

Above: The starter-generator assembled. *Below:* The unit taken apart to show the components. See description in text



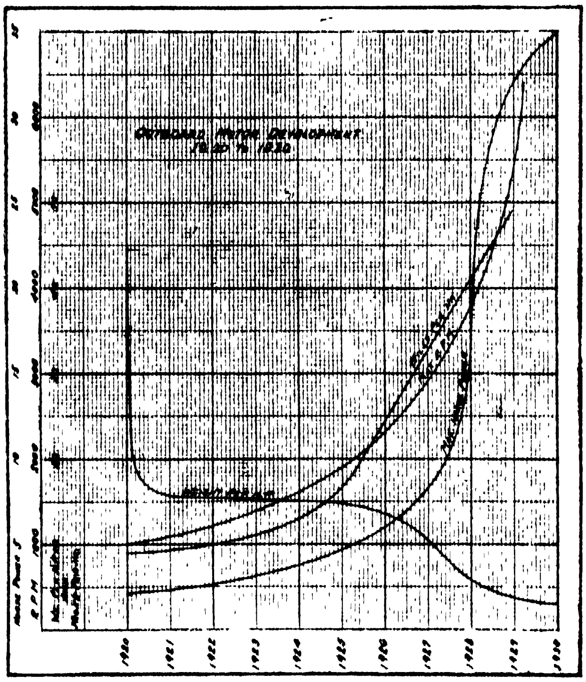
Probably the greatest development, and one which may be due to revolutionize the outboard motor industry, is the new electric self-starter and generator for outboard installation. The Type KB starter-generator, built by the Owen-Dyneto Corporation, is a six-pole, compound-wound, single-unit machine equipped with battery-charge regulator. It is made in two designs, one for use in a six-volt circuit, the other for use in a 12-volt circuit, and is composed of four main sub-assemblies, field frame assembly: armature assembly, brush ring assembly and cover assembly.

The field frame assembly is mounted on top of the engine crankcase and consists of a field frame made from a single steel stamping, six removable laminated pole pieces, and two field windings—a series and a shunt both containing six coils connected in series.

THE armature assembly is of conventional mechanical construction, and is of large diameter with thin stack to accomplish flywheel effect, for it is keyed direct to the engine crankshaft, and serves as the flywheel for the outboard motor. It is of the two-circuit series type, and weighs approximately 16 pounds.

The brush ring assembly is a steel stamping formed for rigidity and is centered in the field frame by six small tongues. The ring mounts the Dyneto battery-charge regulator and three brush holders: two for the main brushes and one for the control brush. The main brush holders are securely riveted to the ring, but the control brush holder is movable, to allow setting of the charging rate by movement of the control brush. The battery-charge regulator automatically regulates the charging rate as the voltage condition of the battery warrants.

When the starting switch is turned to the "on" position, the starter-generator first operates as a motor and spins the engine at from 400 to 450 r.p.m. After the engine begins to run under its own power, at speeds above approximately 1000 r.p.m. with the six-volt unit, and above approximately 1500 r.p.m. with the 12-volt unit, the machine automatically operates as a generator and charges the battery; at lower speeds it operates as a motor. The power available from the starter motor increases as the speed is diminished and absolutely prevents the motor from stalling.



The curves on the accompaning chart indicate what have been the influencing factors in the outboard motor industry in the last ten years, and may serve as a basis for prediction.

It would appear that weight-per-horsepower reduction could not continue to drop off at its present rate. Revolutions will probably continue to mount higher and higher and this, of course, will mean more horsepower, and consequently greater speed.

The obvious advantages of the four-cycle engine will help in the development of this type of outboard but the question may be raised as to whether the more delicate mechanism, with its multiplicity of parts, will stand the abuse the public is now giving the two-cycle outboard motor. The question also arises as to whether the boating public will be willing to pay for the much more expensive four-cycle type of motor, even with the great saving in operating cost.

IT seems reasonable to predict that outboard motors will be developed with an increased number of cylinders. It is possible that something will be done along the line of the German Junkers opposed-piston two-cycle Diesel engine.

Just what is in the future it is hard to say. But one thing is certain: the outboard motor is here to stay. It is filling an increasingly large place in the outdoor life of America and, like the "flivver" or the motorcycle, may develop from a hobby to a necessity.

The outboard motor will soon be made so fool-proof that anyone will be able to drive it. And, just as the automobile is today, it will be operated by many a man, woman, and youth who knows little or nothing about what makes the wheels go round.

Michelson

An Appreciation of America's Foremost Optical Physicist[*]

By PROFESSOR WILLIAM H. CREW[†]
Physicist, United States Naval Research Laboratory

IT is my purpose to sketch briefly the scientific achievements of the man whose first researches were carried out at the United States Naval Academy over 50 years ago and who now, at the age of 76, has set for himself three tasks which to others, even in his own field, seem almost Herculean. And furthermore, it will be interesting to note the far-reaching significance and influence on contemporary thought in physics that may be attributed to these major researches of Professor Michelson.

More than three quarters of a century have passed since Albert Abraham Michelson was born in a small village, Strelno, just 40 miles from the birthplace of Copernicus and then, in 1852, a part of Germany, but now within the borders of Poland. But during practically all of that time he has lived in America as a citizen of the United States.

AT the age of 16 he was appointed by President Grant as a midshipman at the United States Naval Academy and was graduated four years later in the class of 1873, or as then designated, "Date of '69." One reads with interest Admiral Fiske's account[1] of his boxing tilt with Michelson when they were schoolmates at the Naval Academy, a fight from which Fiske emerged in rather the worse condition. However, upon the admiral's own admission, his admiration of Michelson the "pugilist" is surpassed by his admiration of Michelson the physicist. We also learn from Admiral Fiske that an innate interest in physical experiment and evidence of unusual ingenuity were observed in Michelson during his years as midshipman; although Admiral Worden,[2] so it is alleged, was a bit concerned for the future of one who devoted so much of his time to extra-curricular experiments. Humanity may be thankful for the influence that then permitted the individual to follow his true bent undeviated by the rigid restraints of a military régime.

Not very long after graduating, Michelson was detailed to the Naval Academy (1875-1879) as an instructor in mathematics and physics, and at that time he outlined in a simple, characteristic half page in *Nature*[3] an improved method of determining the velocity of light.

Before the Navy had established a post-graduate school, certain officers were selected and sent abroad for graduate study, and in this line of duty Michelson spent the years 1880 to 1882 in Berlin, Heidelberg, and Paris; and in the following year he resigned from the Navy to enter upon an academic career. It is interesting to note that 36 years later (1918) he was again on the Navy Register, enrolled in the United States Naval Reserve Force as a specialist. I recall with pleasure making a visit during the War to the roof of his laboratory at the University of Chicago where he was developing an optical range finder for use by Navy vessels.

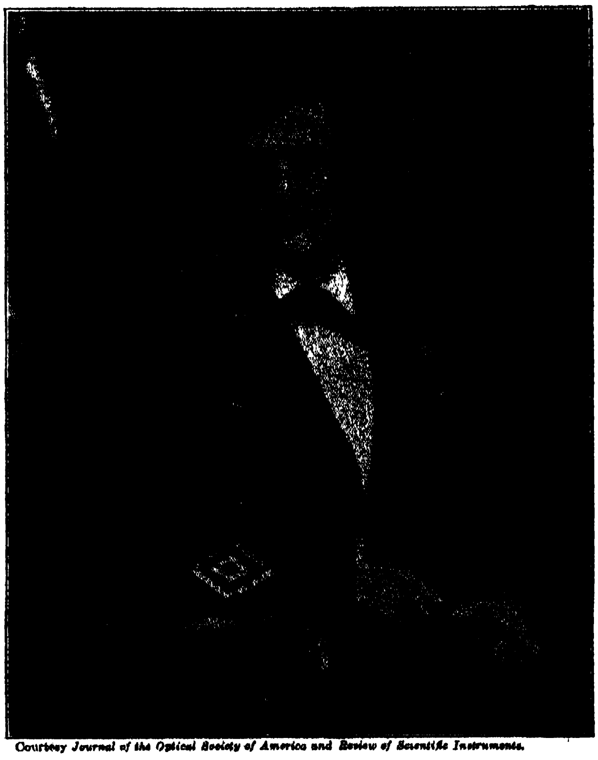
FOLLOWING his early Navy career, Michelson became a professor of physics first at the Case School of Applied Science at Cleveland and later at Clark University at Worcester and finally, since 1892, at the University of Chicago, to which he was called as head of the Department of Physics.

The recognition of Professor Michelson as a scholar and an investigator of the highest order is borne out by the many honors, both foreign and domestic, of which he has been the recipient. His awards, such as the Rumford Medal, the Copley Medal, and so on, are too numerous to mention here, but one cannot resist pointing particularly to the fact that Professor Michelson was the first American physicist to receive the Nobel Prize Award.

Although for nearly 40 years Professor Michelson has made his home in Chicago, much of his time has been recently spent in California where, even during the past summers, he has been repeating the ether-drift and velocity-of-light experiments, always with new and improved technique, increased precision, and with convincing results. It is thus that we learn of Michelson, at 77, outlining three new tasks which are in brief: the re-determination of the velocity of light; a refinement of the measurement of the diameters of stars; and another search for a possible ether-drift.

It may be of interest to review very briefly the principle researches of Professor Michelson; and then to consider their bearing and influence on current physical thought.

PROBABLY the first serious effort to find out whether or not the velocity of light is finite was made by Galileo; but the crudeness of his experiments left him with no evidence that the passage of light from one point to another was not instantaneous. In 1676 the Danish astronomer, Römer, pointed out that inequalities of the time intervals between eclipses of Jupiter by one of its satellites may be accounted for by the varying distance of the earth from that planet due to the periodic motion of the earth about the sun and at the same time assuming a finite velocity of light of about 192,000 miles per second. Subsequently, short-range determinations of this velocity were made, and noteworthy were the toothed-wheel experiments of Fizeau (1849) and Cornu (1874), and at the same time the revolving-mirror experiment of Foucault.



Courtesy *Journal of the Optical Society of America* and *Review of Scientific Instruments.*

MICHELSON AS A MIDSHIPMAN

His first determination of the velocity of light (*Scientific American Supplement*, Sept. 18, 1879) was made about five years later when he was a young teacher

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[*] Reprinted by courtesy of *United States Naval Institute Proceedings.*

[†] See "Among Our Contributors," page 341.

[1] Fiske, "*From Midshipman to Rear Admiral,*" page 15.

[2] Admiral Worden was then superintendent of the United States Naval Academy, and formerly was commanding officer of the ironclad *Monitor.*

[3] *Nature*, 18, 195 (1878).

The method of determination of the velocity of light as proposed by Michelson in 1878 was that of the revolving mirror, driven by an air blast and calibrated against a tuning fork of accurately known frequency. The apparatus for this experiment was set up along the sea wall of the Naval Academy at Annapolis, a position which is now occupied by the tennis courts. Here an unobstructed path of 500 feet between mirrors was obtainable. The results of this experiment were published in the *Proceedings of the American Association for Advancement of Science*[4] in 1878, and the best value obtained, 186,508 miles per second, was a mean of ten independent observations "made under difficulties, and with apparatus adapted from material found in the laboratory of the Naval School."

In the years subsequent to 1878, improvements in the measurements of the two fundamental factors in this experiment, the *distance* interval and the *time* interval of the passage of the light beam, have been made under the direction of Professor Michelson. The distance between mirrors in the 1924 determination[5] was about 22 miles, accurately measured for the purpose by the United States Coast and Geodetic Survey, between Mount Wilson and Mount San Antonio in California. The rotating mirror in this case was in the form of an octagonal prism, each face being an optical flat, and it functioned also as a timer by virtue of its calibration with a standardized tuning fork. This experiment has given what is by all odds the most trustworthy value of the velocity of light, namely, 186,359 miles per second in air.

PROF. MICHELSON MAKING A SKETCH

Water color sketching is his recreation. So also is the refinement of accuracy in the determination of "*v*"

In the early eighties, when in Germany, Professor Michelson's interests were first directed to the "Aberration Question," which in short was this: "Does the medium, usually called 'ether,' in which light waves are propagated through empty space, remain fixed with respect to the stellar universe while the earth moves freely through it; or does the earth drag the ether with it, as a rapidly moving vehicle carries a quantity of air with it into its motion?"

A study of this question, both experimental and theoretical, has led the way to a vastly greater comprehension of the universe in which we live than has, perhaps, ever been realized before. In particular, the results of the now famous "Michelson and Morley Ether-Drift Experiment," carried out at Cleveland in 1887, gave the initial impetus to the theory of relativity. Let us consider this far-reaching experiment.

As early as 1880, Professor Michelson conceived the idea of making a direct test for ether-drift by sending simultaneously two beams of light waves out from a point in two mutually perpendicular directions, and by means of mirrors reflecting each back along its own path to the starting point. If during such an experiment there is no drift of the ether, the two beams of light waves will arrive together in step; but, on the other hand, if there is a drift of the ether along the path of one of the light beams, then the two sets of waves will arrive somewhat out of step. To measure such a possible "out-of-stepness" Michelson invented (1882) a simple but tremendously ingenious interferometer, an instrument which has since found application in many and various types of optical measurements.

His first effort to detect ether-drift with an interferometer was in Helmholtz' laboratory in Berlin; but here the vibrations due to city traffic made the use of this instrument impossible, and accordingly the apparatus was moved to Potsdam. The results obtained there, however, were considered inaccurate and therefore of no significance, and were disregarded.

Upon returning to America, Professor Michelson, assisted by Professor Morley, built an interferometer on a large scale at the Case School of Applied Science; and there they made the surprising observation that the light waves reflected back along the two perpendicular paths of the interferometer met one another "in step." The immediate interpretation of this was that there was *no relative motion*, that is, no drift, between the earth and the ether. This experimental observation was repeated later, and with increased precision, by Morley and Miller at Cleveland, and by Michelson at the University of Chicago and in each instance the original Michelson-Morley experiment was substantiated.

THIS experimental result which indicated no ether-drift was in contradiction to the supposed facts deduced from observations of aberration; and as late as 1900 Lord Kelvin, at the International Congress of Physics held in Paris, averred that the "only cloud in the clear sky of the theory of the ether was the null result of the Michelson-Morley experiment." But at about that time Lorentz, in Holland, and Fitzgerald, in Ireland, proposed an hypothesis to make compatible the results of the Michelson-Morley experiment and the earlier aberration experiments; and it was this hypothesis, now usually referred to as the Lorentz-Fitzgerald contraction hypothesis, on which Einstein founded his theory of relativity in 1905. The influences of this theory are too numerous and too profound to mention here, but suffice it to say that they have introduced entirely new and extremely interesting speculations as to the structure of atoms and in general the nature of things.

In the years 1921 to 1925 very extensive ether-drift experiments were carried out by Professor Miller at the Mount Wilson Observatory in California. Physicists the world over were astounded when Professor Miller announced an observed motion of the ether of about ten kilometers per second; for such a result was apparently in disagreement with the Michelson-Morley experiment and with the theory of relativity. Professor Miller then carefully repeated the experiment and verified this former result, but the same experiment was done independently at Mount Wilson by Dr. Roy Kennedy, who found no evidence of an ether-drift. A few years later Professor Michelson went to California and there repeated his ether-drift experiment, and in November of 1928 at Washington he announced to a very eager and attentive audience at a meeting of the Optical Society of America the result of this last and most precise experiment—no observ-

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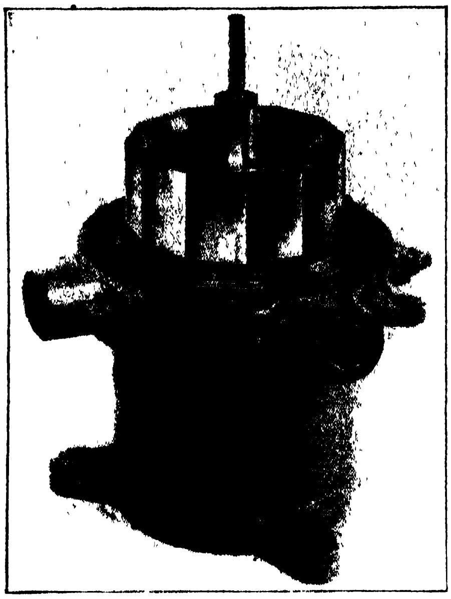
[4] This article has recently been republished in the *Scientific Monthly* for December, 1928.

[5] Michelson, *Astrophysical Journal* **60**, 260 (1924)



MODELS OF 1926 AND 1879

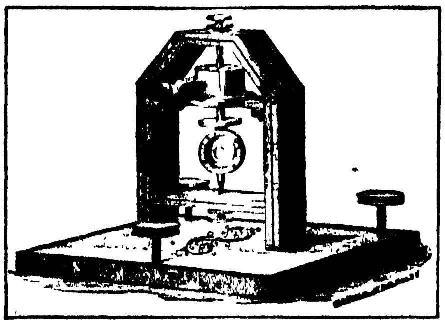
Above is the 12-sided mirror (made by the Sperry Gyroscope Co.) most recently used, and at right the simple mirror of the first determination, reproduced from the *Scientific American Supplement*, 1879

able ether-drift. The contrary results of Professor Miller's experiments, done under his keen supervision and skillful hand, still stand unexplained; but the situation, as recognized by the scientific world, is that relativity remains vindicated.

I wish to refer briefly to some of the other important achievements of Professor Michelson. I have mentioned the interferometer which was devised by him for the purpose of determining a possible ether-drift. This same instrument has found most remarkable applications in other fields of science, notably in the measurement of the distance between components of double stars and in the measurement of the diameter of the giant star Betelgeuse. In this latter instance an interferometer was mounted on the end of the 100-inch reflecting telescope at the Mount Wilson Observatory; the diameter of this great star, located in the constellation of Orion, was calculated to be 240,000,000 miles, a distance about equal to the diameter of the orbit of Mars.

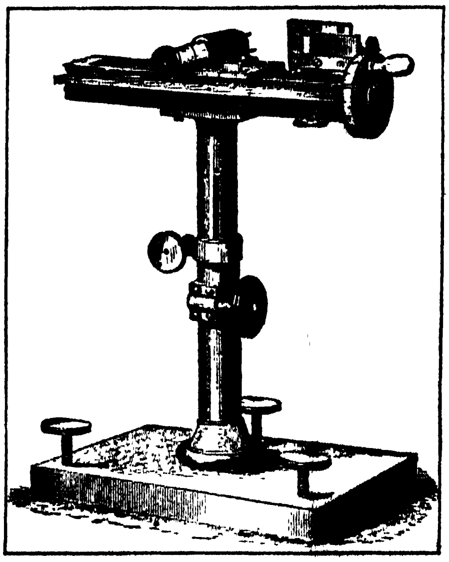
THE international standard of length is the distance between two scratches on a particular bar of platinum-iridium kept at Sèvres near Paris, and is known as the standard meter. In order to establish permanently this standard of length so that it might never be lost to mankind due to material destruction, Professor Michelson spent the first year of his appointment at the University of Chicago in Paris in determining this length in terms of the wavelength of a particular red line in the spectrum of cadmium. For this purpose again the interferometer was brought into use and a most accurate determination yielded the result that one meter is equivalent to 1,553,163.5 wavelengths of this particular red cadmium line. And now we may rest assured that even though the standard meter of Paris be destroyed by war, by vandalism, or by natural causes, it could be again reproduced to within an accuracy of at least one part in 3,000,000. It is a remarkable thing and a fortunate one that the wavelengths of the light in the spectrum of any element such as cadmium are identical the world over and probably throughout the entire universe.

From the brief résumé of Professor Michelson's achievements it may be concluded that their distinguishing feature is precision. The economic value of these experiments of precision can not be estimated in numbers but their use in promoting useful and properly directed thought is inestimable, and an interesting discussion of these uses has been given by Professor Millikan in *Science* for May 10, 1929. Certainly of greatest importance, in my mind, is the ether-drift experiment which triggered off the study of relativity, which in turn has promoted thought along the lines of atomic structure, has introduced the notion that energy is intimately related to mass, and has finally led to exceedingly interesting speculations as to the constitution of stars. Knowledge along this line certainly seems worth while in that, possibly, our future source of energy may be the stars, or, in particular, the sun.



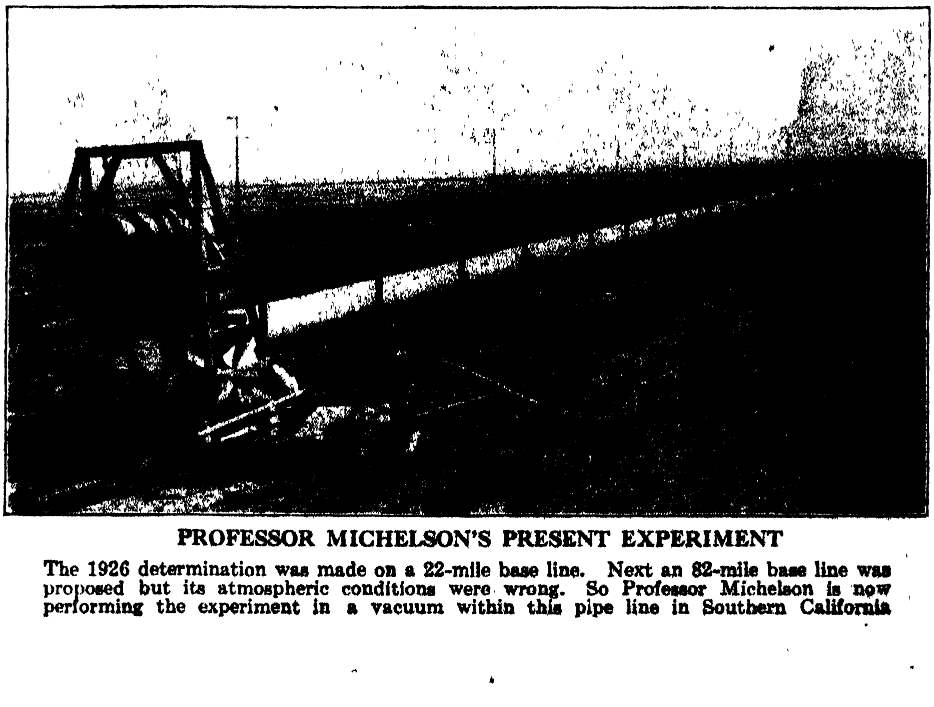
As the Copernican theory led mankind away from geocentric ideas, so has the theory of relativity led him away from egocentric ideas; that is to say, one can no longer honestly estimate velocities and accelerations with respect to himself but must also extend to other stars and even other universes the privilege of being the basis of reference. A most entertaining and illuminating discussion of this subject is to be found in Eddington's recent book, *The Nature of the Physical World.*

These valuable scientific researches in themselves stand as evidence to the skill and mental prowess of Professor A. A. Michelson as an investigator, and the United States Naval Academy may well be proud to count him as one of its graduates, but these researches are apparently not the last.



APPARATUS USED IN 1879

For measuring the deflection of the beam. Note screw head, divided circle, adjustable slit at the top, right, and eyepiece



PROFESSOR MICHELSON'S PRESENT EXPERIMENT

The 1926 determination was made on a 22-mile base line. Next an 82-mile base line was proposed but its atmospheric conditions were wrong. So Professor Michelson is now performing the experiment in a vacuum within this pipe line in Southern California

The Aerial Ferry Arrives

Operating at Frequent Intervals, Amphibions Carry Passengers on Regular Schedule

SHORT-HAUL air transportation has been tried out successfully in California between San Francisco and Oakland. The regular trip by boat and train ordinarily consumes 40 minutes, while the seven-passenger amphibion makes the trip in six minutes. The one-way fare is $1.50, but regular commuters may effect an economy by the use of scrip books. This is the shortest and most frequent air service in the world. In the first 19 days of operation the three Keystone-Loening amphibion air yachts carried 8330 passengers. Approximately 110,000 persons cross the bay daily and therefore there will always be potential patrons for the air-ferry service.

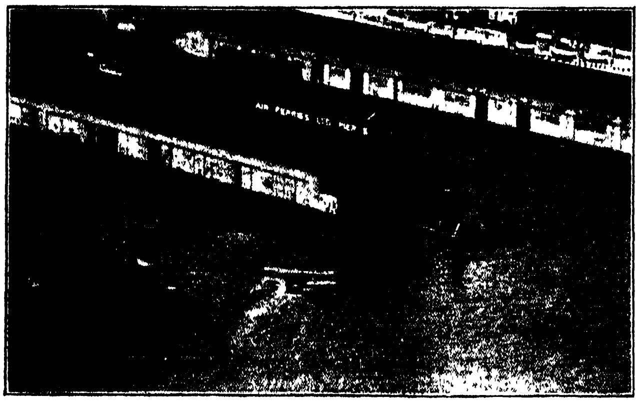
What made short-haul air service practical, however, was that Air Ferries, Ltd., brought its airplanes to the centers of business and transportation. The quick accessibility of the water-front terminals and the amphibion equipment made it possible to turn to advantage the waters of San Francisco Bay—the same medium which has been the chief obstacle to transportation between the communities which lie inside the Golden Gate.

THE air ferries operate across the bay on a more frequent schedule than even the ferryboats, the long established means of transportation. The ferry steamers leave every 20 minutes. They debark passengers at Oakland mole, a trestle reaching far out into the bay, whence electric trains carry them through the East Bay district. By the use of air ferries, it is now possible to make the trip between the actual business centers of the two cities in approximately 18 minutes.

The 30,000-dollar Loening amphibions carry seven passengers and two pilots each, and cruise at a speed of 105 miles an hour. They take off from the waters of San Francisco Bay or Oakland estuary at a speed of 85 miles an hour, after an 18-second run, and have a landing speed of 55 miles an hour. They are powered with 525-horsepower Pratt and Whitney Hornets. Passengers step directly in and out of the planes, without having to travel in boats, climb ladders, or approach moving propellers. The air ferries are 34 feet 8 inches long, weigh 5900 pounds, have a wing span of 46 feet 8 inches, and can cruise 550 miles on a tankful of fuel. The gasoline consumption is about 26 gallons an hour.

◄ ABOVE OAKLAND

The actual flying time between San Francisco and Oakland is six minutes



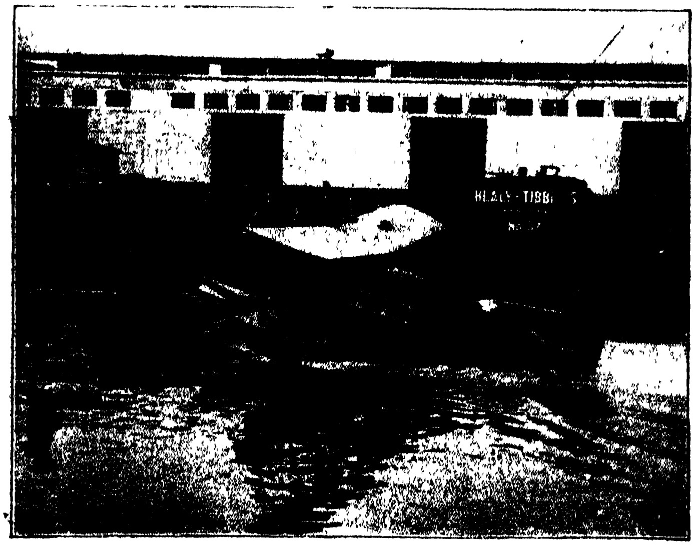
AIR VIEW OF DOCK

The amphibion is approaching the ramp where passengers will debark. The pier shed has been converted into a hangar

Additional service will be provided soon to Vallejo, Sacramento, Stockton, and other points. The flying time to Sacramento—89 miles—will be 55 minutes. Night service is planned as soon as the necessary lighting equipment is installed.

THE OLD AND THE NEW

In the foreground is one of the amphibion air ferrys. In the background is one of the stern-wheelers that are still in service



LIKE A DUCK

The amphibion air ferry lands on the water and taxies along the surface to a ramp up which it climbs under power of its engines

Our Air Analyzed

How Science Fights the Smoke and Dust Evils of Our Cities

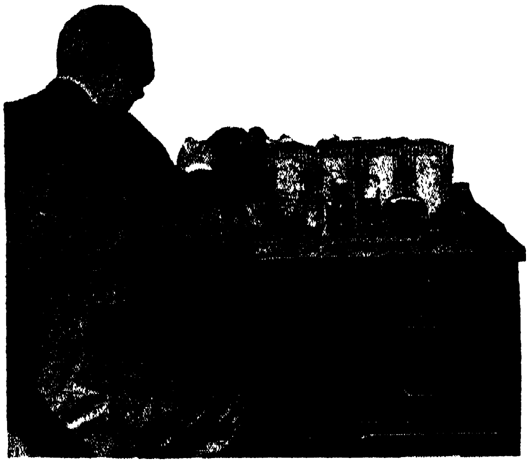


PHOTO-ELECTRIC CELL IN ACTION

Here we have H. B. Meller, head, Mellon Institute investigation, experimenting on the photo-electric cell for measuring atmospheric contamination

THE nuisance of smoke and dirt is present wherever fuel, particularly soft coal, is burned. Everyone detests smoke, but until comparatively recently not much constructive effort was made to get rid of it. Now, however, smoke abatement is a live subject in communities throughout the country. One hundred and twenty-five cities of more than 30,000 population have smoke ordinances of one form or another, more or less strictly enforced. Scientific research is being carried on in a few centers, but unfortunately the efforts as yet are not concerted and there is some unnecessary duplication.

At least one of the most outstanding organizations in the field of smoke abatement is Mellon Institute of Industrial Research in Pittsburgh, which in the past has made two surveys of conditions in Pittsburgh, and now is engaged in a third of broader scope.

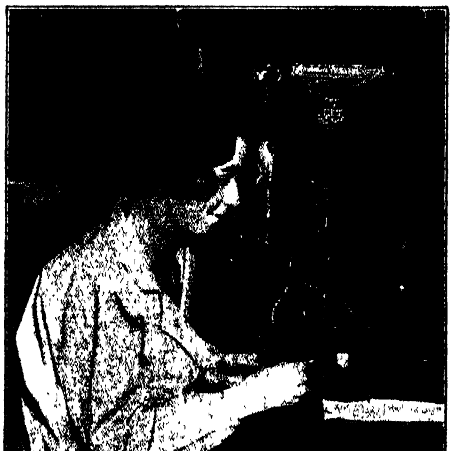
The first survey was made in 1912 to 1914. Not only were determinations made of the amount of sootfall in different parts of the city, but conditions in plants making unnecessary smoke were investigated. The effects of smoke on health, on vegetation, on meteorological conditions, and on paints, building materials, and interior decorations were studied.

SAMPLES of precipitated matter collected monthly for twelve months were analyzed to determine the percentages of tar, combustible matter other than tar, and ash. The results showed that an average of about 1000 tons of solid matter was being precipitated per square mile per year in the city of Pittsburgh. Of this 10 tons was tar, about 300 tons combustible matter other than tar, and about 700 tons ash.

Following this survey, an anti-smoke ordinance was passed and has since been in effect. This ordinance prohibits dense smoke of two minutes or more duration in any period of 15 minutes, and dense smoke is considered to be equivalent to Number 3 of the Ringlemann chart. In a practical way, this may be said to be smoke of such density that it is not possible to see through the stream as it leaves the stack. This is the limit placed in the average ordinance, because with available equipment and under present operating conditions, a closer limit had not seemed feasible.

After ten years, or in 1923, it was desired to determine what results had been attained under the ordinance. Samples were collected and analyzed exactly as in the first instance. The marked difference was in the reduction of tarry matter by about two thirds. In other words, enforcement of the ordinance was successful in materially reducing prohibited dense smoke. On the other hand, the total weight of solid material deposited had increased by about 40 percent.

This brought up the question of whether the purpose behind the ordinance was being served; but since there is at present no feasible universal method of eliminating solids not visible to the naked eye and noxious gases that may accompany these solids, it did not seem advisable to suggest any changes in the law. The need for further study of the problem was indicated, however, and in 1928 Mellon Institute entered upon its third survey, this to cover many phases not previously considered.



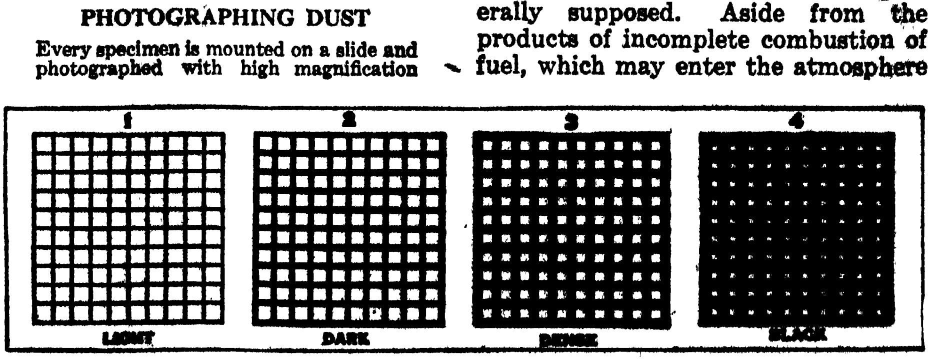
PHOTOGRAPHING DUST

Every specimen is mounted on a slide and photographed with high magnification

THE work now in progress may be grouped as follows: Determination of amounts and compositions of solid matter and gases at the sources; a study of the distribution and behavior of these solids and gases after they are introduced into the atmosphere and their effects, particularly in screening out sunshine; the possibility of developing methods to prevent such solid particles and objectionable gases from getting into the atmosphere.

In order to determine approximately the amount of contamination from stacks, it is necessary that tests be made of various kinds and sizes of boilers and furnaces, some hand-fired and some equipped with stokers, using the different kinds of fuel available in the district, with good draft and with poor draft, and with light load and heavy load; in other words, to make enough tests in a given case to say approximately what amount of pollution is being contributed. If it is desired to determine the approximate total for a city, it remains then to tabulate the plants in accordance with the grouping of the tests. These groupings may include stationary plants, locomotives, steamboats, and portable boilers such as steam shovels and hoists.

The automobile may be a greater source of contamination than is generally supposed. Aside from the products of incomplete combustion of fuel, which may enter the atmosphere



THE RINGLEMANN CHART USED IN PITTSBURGH

Place the chart on a line with a stack a sufficient distance from the eye to cause the lines to merge. Compare with the density of smoke under observation; if equal to or greater than 3, the smoke is a violation of the city ordinance and the operator is liable to penalty directly, there is the fact that they are emitted at a low level, and therefore are more of a nuisance and more damaging than if they entered the atmosphere at the level of the ordinary chimney. There is the added fact that the movement of the wheels and the force of the exhaust raise dirt from the street.

IN any study of air pollution in a city, it is important to determine how much is being contributed from outside the city. Obviously, if it is desired to clean up, plants not within the city limits but close enough to add materially to the dirt must be considered.

After the solids and gases leave the stack, they are acted upon by the wind currents. Gases are diffused and the heavier solids dropped almost at once to the ground. Those of intermediate weight drift slowly downward and reach the ground at greater or lesser distances from the source. The lighter solids are retained in suspension and travel with the wind, and naturally some of the particles that drop at one wind velocity may be picked up and dropped repeatedly as that velocity varies. And, of course, the nearer to the ground, the greater the percentage of intermediate or heavier particles in suspension.

To determine the amount of material that may drop, and the amount that may be in suspension, the two following methods have been employed:

1. Containers are placed at different locations (20 stations being used at present in the city of Pittsburgh), and the amount of material that drops into the container is weighed and analyzed. In order that the effects of various weather conditions may be considered, there are two containers at each station, one being changed daily for the purpose of determining the sootfall in 24 hours, and for the additional purpose of comparison with weather conditions during that period, and the other changed each month so that there shall be enough material for accurate chemical analysis.

COLLECTING AND MEASURING

Above: At twenty stations dust is collected daily and monthly for weighing and chemical examination. *Left.* The assistant is transferring a sample from a collecting vessel to a glass beaker

2. The solid matter in suspension is sampled by means of the Owens Jet Dust Counter. The solid particles are precipitated on glass, and then this glass is mounted on a slide for study under the microscope. The number of particles is counted and the sizes are measured. Samples of this character are taken daily at strategic points, and these results also compared with the records obtained from the Weather Bureau.

WEIGHING THE DUST

After drying the samples of collected dust deposits, the weights of the latter are ascertained with accuracy. The experiments are carried on with care and the results are tabulated

THE SPECTROGRAPH

A spectrograph is used daily, if the weather permits, to measure solar radiation

WHILE the effects of air pollution on vegetation, building materials, paints, and so forth, are fairly well understood and were studied carefully as a part of Mellon Institute's investigation of 1912 to 1914, what is considered one of the very important effects of atmospheric contamination is the reduction, through absorption and scattering by the solid particles, of the beneficial rays of the sun. To secure information concerning the extent of this screening, a quartz spectrograph is used as the basis for standardization of other instruments and other methods, and for taking, at stated intervals, photographs of the solar spectrum. Most of the work will use the photo-electric cell.

The behavior of various kinds of dusts is being studied in an air-tight dust chamber, so that it is possible to use samples having known quantities of definite kinds of solid material. The action of each of these is studied with the spectrograph and the photo-electric cell.

It is obvious that an investigation of this broad character, even assuming the possibility of securing all the data desired, would not be of maximum value unless methods were developed which would make possible the suppression of at least a considerable part of the evil. Consequently one phase of this research looks toward such development.

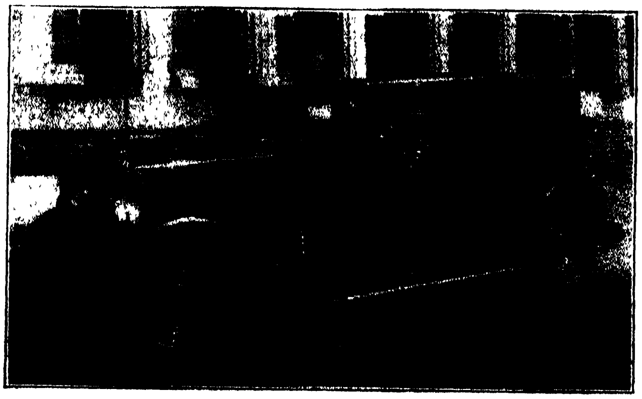
A Diesel Drives an Automobile

Stock Marine Diesel in 6000-pound Car Chassis Makes 2780 Miles on $7.72 Worth of Fuel Oil

By WILLIAM F. STURM

ONE of the most interesting engineering demonstrations of recent years, and one fraught with portent for the automotive industry, was a test trip made by a Diesel-engined automobile from Columbus, Indiana, to Indianapolis, New York, Detroit, and back to Columbus—which, for the benefit of those short on geography, is just 40 miles south of the Indiana state capital.

The trip of 2780 miles was important in that it marked the first time in America that a Diesel engine ever had been used to drive a regular automobile. The trip proved conclusively that the Diesel engine is flexible enough for automotive power plants and it opened the eyes of engineers to the possibilities of an engine that not only would perform satisfactorily in an automobile chassis but would do so on fuel oil which may be purchased at from eight to ten cents retail and which will drive a car at a speed of 55 miles an hour over all kinds of roads, hills, and detours.



THE DIESEL-ENGINED AUTOMOBILE

This car, the first in the country to be driven by a Diesel, was easily operated and its fuel economy was exceptional

THE engine used was of four cylinders, with a 4½-inch bore and a six-inch stroke, developing approximately 50 horsepower. The test trip engine was not one specially built for automobile use, but one taken from regular production for portable and marine use. The chassis was from a 1925 model of a well-known automobile, and the change was made simply by removing the automobile engine and replacing it with the Diesel. The heavy base of the Diesel was removed and fittings necessary to anchor it to the frame members of the automobile chasis were added. It was not necessary to change the hood or radiator alignment, nor to disturb the rest of the chassis in any way.

So well did the car perform, from the standpoint of flexibility, that no difference was discernible between it and the standard type of automobile. Mr. C. L. Cummins, president of the Cummins Engine Company, of Columbus, Indiana, drove the car into New York at the busiest hour of the day, between 4 and 5 P.M., and parked it at the Roosevelt Hotel. In all the larger cities he visited—New York, Philadelphia, Baltimore, Washington, Pittsburgh, and Detroit he asked no odds of anyone in traffic. The greatest tribute to the engine performance is that until one came close enough to read the small sign, "Diesel Test Car—Cummins Engine Company," on the tire cover, he was not aware that it was not a conventional automobile.

No extensive experiments were made with the car prior to its long trip; in fact, the finishing touches were placed on the car at 9:30 in the morning and it left an hour and five minutes later for New York, making the trip in 25 hours driving time.

On the trip from Indianapolis to New York—792 miles—the fuel oil consumption was 30 gallons and the cost was $1.38. One must be honest, however, and say that this low cost was due to the fact that most of this oil was purchased at wholesale at the Cummins factory for 4 cents a gallon. But even had the top retail price of 10 cents a gallon been paid for the 30 gallons, the cost would have been only three dollars, as against 99 gallons of gasoline at a cost of $24.75 for the same chasis with a gasoline engine consuming a gallon of gas every eight miles. On the 2780-mile trip, 102 gallons of fuel were used. The cost of this was $7.72, as against a fuel cost of 86 dollars at 25 cents a gallon for a gasoline engine.

The actual average per gallon, with the car running wide open most of the time and no attempt made at fuel economy, was 27.2 miles, which includes distances between cities and mileage used within city limits in demonstrating the car. The full cost per mile was less that three mills, yet the car weighed 6000 pounds.

"We made the trip merely to demonstrate that the Diesel engine, as it is made today for marine and portable use, can be used successfully in an automobile," Mr. Cummins said. "I had listened so long to the statements that a Diesel is not flexible that I decided to demonstrate the falsity of the statement, at least so far as our product is concerned. The engine we used was not an automobile engine at all. But even without being especially adapted to automobile use, it met the occasion surprisingly well. We are certain that development can successfully meet the service conditions met with in trucks, buses, tractors, and similar services. It can be adapted to passenger car use—particularly for export—as easily as to trucks and buses.

"HOWEVER, the refinement of the motor, the path to passenger car use, lies through the truck field, simply because the matter of weight is not so vital in the truck and bus field as in the passenger-car field. I would like to make this plain—that the marine Diesel is entirely too heavy for even the ocntemplation of its use without refinements in the passenger car."

The matter of automotive adaptation is only one of engineering the engine to the problem at hand. When this is done, Mr. Cummins says that instead of 28 pounds per horsepower the weight can be reduced without injuring the life of the engine and its performance so that the automotive engine weight will not exceed 10 pounds per horsepower. This compares favorably with the average automobile engine of today.

The Diesel develops its power at low engine speeds, as evidenced by the engine used in the test trip. It was equipped with a governor which took the engine away from the driver at 1300 revolutions a minute, yet the car ran perfectly at a speed of 55 miles an hour. Further, one might expect the motor to vibrate considerably at low speeds, yet in the hundreds of miles the writer rode, he found its vibration no worse than any four-cylinder engine of its size. As the speed increased and 15 to 20 miles was reached, the engine smoothed out and ran as smoothly and as quietly as any gasoline engine. Its acceleration at 20 to 50 miles an hour was surprising, especially in view of the 2½ to 1 gear which was used in the car, instead of the 4.69 to 1 used with the original eight-cylinder engine.

The engine was started with a 12-volt motor-generator which, after starting the engine, becomes a generator to re-charge the battery. By a turn of a lever on the dash, the compression in the cylinders was released while the starter turned the engine over. After 10 or 12 revolutions of the motor to get up speed, the compression-release lever was turned to re-establish compression, and the momentum engendered started the engine instantly and as easily as the normal car starts. There are no carbureter and carburation problems on a Diesel. If the oil in the cylinder walls is loose enough to permit the motor to turn over, that is all that is asked. Whether the atmosphere is 40 degrees above zero or 40 degrees below makes no difference to a Diesel. The car was left out on a parking lot at Pittsburgh for two nights at zero weather and it responded instantly after standing 13 hours. On the compression stroke the air charge becomes heated to approximately 1000 degrees, Fahrenheit, and away she goes.

It may interest the lay public to know that, with the exception of the firing by heat induced by compression, and injection of the fuel into the explosion chamber thus heated, the four cycles or strokes are exactly the same as in the standard type of automobile engine. The engine which was used has neither spark plugs nor any other type of spark ignition and no carbureter. In place of plugs, it depends on heat generated by compression of the air charge in the cylinder to ignite the fuel. In the gasoline engine the charge consists of gasoline vapor and air mixed; in the Cummins engine pure air only is drawn into the cylinders. On the compression stroke this air is compressed to 500 pounds per square inch, which generates a heat of approximately 1000 degrees, Fahrenheit. While the air is at its highest compression and temperature, the fuel (in a gaseous state) is injected into the explosion chamber by suitable mechanism. On contact with the heated air it ignites and burns progressively, instead of explosively, as in the gasoline engine, and creates the power stroke of the engine.

Mr. Cummins says his engine differs from the conventional type of Diesel because in the latter the solid fuel is injected at pressures varying from 3000 to 10,000 pounds, and as considerable time, comparatively, is required to gasify the cold, wet fuel, it is injected considerably ahead of the top center stroke of the piston, which results in heavy explosive pressures in the cylinder, making extremely heavy moving parts mandatory to withstand the strain.

In the Cummins engine, the fuel is pre-heated by circulating it around through an annular space between two members of the injection plunger chamber. Fuel stands in this annular space through three cycles of the engine, namely, the compression stroke, the working stroke, and the exhaust stroke. At the beginning of the suction stroke, this pre-heated charge is forced out of the annular space into a small conical chamber, where it stands over the small distributing nozzles which lead out into the combustion chamber. A plunger operating in this chamber is slowly retracted at the time the fuel is delivered into the chamber, which prevents any of the fuel being forced out into the main combustion chamber. On the compression stroke, the final preparation of the fuel is completed. The highly compressed air charge from the main cylinder is forced through the nozzles up through this pool of previously heated fuel, thus cracking and gasifying the hot charge of wet fuel. When the piston is at approximately top center, the plunger is suddenly depressed, thus driving the rich gaseous charge of fuel out into the hot compressed air charge in the main cylinder, where ignition takes place and combustion follows.

Previous practice in Diesels has called for a plunger or valve for each cylinder, and it has been found impossible to keep these accurately adjusted to measure the proper amount of fuel under the extreme pressures under which the fuel is fed. In the Cummins engine, one plunger measures and delivers the fuel to all injectors, whether one or six, at a pressure of only 50 pounds. A distributor distributes this measured charge from the common plunger to the proper injector, thus eliminating any possibility of unequal distribution of fuel.

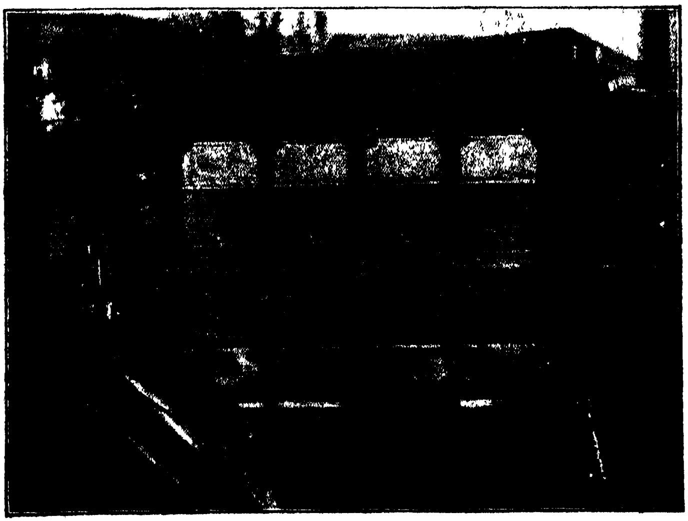
The entire fuel system may thus be divided into three divisions, the first of which covers the measuring of the fuel charge and delivering it to the injectors. The second covers the gasifying of the charge in the injectors and injection into the combustion chambers. The third division covers a means of obtaining the necessary turbulence or mixing of the combustion charge with the air in the cylinders.

Because of this advanced preparation of fuel and the method of measuring, the Cummins engine will handle any kind of fuel from crankcase slop to gasoline.

The plan of the manufacturers is to adapt this engine to truck use first, by experiments under actual truck working conditions. Bus application will come next, with the passenger car last. This means that the engine should be perfected for trucks within a year or 18 months and that if the passenger car adaption comes, it will be a matter of four or five years before it is perfected.

FUEL OIL DISTRIBUTION

Right side of Diesel showing fuel lines. Right-hand lines carry oil to cylinders; left-hand lines carry excess oil back to reservoir



THE FOUR CYLINDERS

Left side of the Diesel showing the fuel distributing pump directly behind radiator. The rubber hose forward carries cooling water

Edison's Rubber

What Mr. Edison Is Doing in His Attempt to Develop an American Wartime, Emergency Rubber Industry in the South

By G. H. DACY

EDISON IN FLORIDA

The picture was snapped during Mr. Edison's inspection of his rubber garden

Mr. Edison Discloses

UNITED STATES Patent Number 1740079, December 17, 1929 (obtainable from Commissioner of Patents, Washington, D. C., ten cents), reveals Mr. Edison's method for extracting rubber from goldenrod and other plants. This method is described by the *India Rubber World* (New York, February 1) as "a modification of the process regularly employed for the extraction of rubber from guayule shrub." (See also page 332, April number, SCIENTIFIC AMERICAN.) In an article entitled "Guayule Rubber" Dr. D. T. MacDougal, Corresponding Editor of the SCIENTIFIC AMERICAN, outlined the guayule process. This was in our number for July, 1928.
—*The Editor.*

DOWN near the tip of our southernmost state where the climate is sub - tropical, Thomas A. Edison has dedicated his early octogenarian years to a problem which he says is of great significance and which may hatch out a successful future rubber-raising industry in the south. Mr. Edison seeks to discover an adaptable rubber plant which will grow prolifically in Florida and other warm-climate states and which may be produced on a commercial scale as a potential wartime necessity—and as a possible billion-dollar industry.

What Mr. Edison has sought from the start of his extensive experiments is plants that would prove suitable for rubber latex production as *emergency* materials. He has denied that he is seeking new sources of commercial rubber which would rival the trees of the tropics that now produce the world's supply of commercial rubber. Thomas Edison is, however, a genius at incubating apparent impossibilities into actuality.

In Edison's ten-acre experimental garden directly opposite his winter home at Fort Myers, Florida, 4000 different varieties of tropical and semi-tropical plants are being grown under the careful culture of experts whom he employs to sift all secrets from American rubber raising. After several years of garden tests Mr. Edison has already demonstrated that at least 1200 of these plants which are able to thrive in Florida will yield good rubber latex.

Like the government botanists and agronomists at Washington who try out the possibilities of new plants imported from all corners of the world in the national quest for more foods for man and animals, Mr. Edison is adverse to publishing his rubber research data until he finds what he is after—or proves conclusively that such plants can not be grown in the United States. He reports that it will involve four more years of intensive technical investigation to ascertain all the answers to the riddle which now occupies his full attention.

AFTER two years of thorough tests, he has eliminated all foreign and imported plants from the research roster, including the notorious *Madagascarensis*. For several months, it looked as though *Madagascarensis* would solve the stubborn secret, but subsequent experiments proved it unworthy. The current experiments are centralized on 1200 plants which either grow wild or are cultivated for ornamental purpose in the south. Most of these are tender tropical plants which can be grown successfully only in such frost-free regions as southern Florida and southern California.

The Edison herbarium at Fort Myers is a rambling structure of concrete in which the experimental specimens of plant life are dried, mounted, identified scientifically, and filed away in spacious fireproof vaults. Propagating material taken from the most promising varieties are planted in three separate propagating gardens, one at Fort Myers, another at Oneco, Florida, and the third at Orange, New Jersey, where Mr. Edison carries on his personal rubber studies during the summer months.

Many of these plants are catalogued in technical nomenclature as weeds, but some of these "weeds" have produced remarkable yields of rubber latex which has proved durable and qualified for specialized uses when manufactured into test samples of rubber. This multiplicity of experimental plants is grown in carefully identified concrete-bordered plots, each of which is four by seven feet in size. The visitor who gains admission to the Florida gardens—and only a few people are admitted, because souvenir seekers have despoiled valuable material—may well imagine himself in some state or national proving grounds of plant research, for that is what the large garden

ONE OF THE PLANTS UNDER INVESTIGATION

Many common plants contain rubber latex, but the plant selected for culture must also meet practical and economical requirements. It must be suited to machine harvesting looks like. Accurate records are kept on the latex production during the plant growing period, and special cutting tests are made to ascertain the best seasons of harvest for the various plants.

The experimental plants are cut by hand and subsequently the harvested material, consisting of stems, leaves, and branches, are run through powerful presses in order to extract all the latex which they contain. Each specimen is analyzed and then is "manufactured" under laboratory conditions into small samples of research rubber. These rubber samples are subjected to a number of critical tests to determine their durability, quality, and suitability for the wide variety of uses to which the product would be put during times of war or peace.

The Florida laboratory, which is manned by a corps of eight scientists employed by Mr. Edison, is equipped with a battery of distillation retorts so that 36 distillation tests of latex specimens can be run simultaneously. The other equipment is complete for the rubber investigations now in progress. Mr. Edison's aides remain at Fort Myers throughout the year and during the summer carry on communication with their "chief" by correspondence, telegraph, and telephone.

HENRY FORD, who owns and operates a 3200-acre plantation farther north near Savannah, Georgia, has offered the use of as much of this land as is required by his friend Mr. Edison for later field tests of those rubber producing plants which prove to have commercial possibilities and which can be grown that far north.* Mr. Ford has also volunteered the services of his mechanical experts and the use of his shops for the development of special harvesting and milling machinery for the transformation of the field crops into finished rubber products. Harvey S. Firestone, the tire manufacturer, is also co-operating with Mr. Edison in these rubber research investigations.

"I believe," said Mr. Edison in discussing the rubber experiments which now monopolize his waking hours, "that those states bordering the Gulf of Mexico can produce plant rubber with profit to the farmer in case of future war prices, and it may be possible potentially to grow rubber in those sections which will compete with the tropics even on a peacetime basis.

"The chemical development of synthetic rubber has no future whatever when plant rubber is quoted at about $.23 a pound, " he continued. "I believe that the manufacture of rubber will be extended in the years to come to a point where it will be employed in the paving and repair of highways. Short sections of test roads made of rubber have now been in service in Scotland for five years with practical success.

"I HAVE found 1200 plants adaptable for culture in Florida which will produce rubber and in my advanced experiments I will cultivate 40 of these on a large scale. I hope to find a plant which may be cultivated successfully in southern Florida so that it will produce an emergency crop of rubber 12 months after planting."

The mechanical puzzles associated with the harvest of rubber plants and the extraction of their latex are not as complicated as they might appear to the layman. The shrub or bush which produces the milky latex will be cut with special tractor-operated mowers. The blades of these mowing machines will be adjustable for cutting the green growth of varying height and size. The arrangement will be such that the harvested twigs and branches will be delivered by special conveyor to wagons and motor trucks driven alongside the mower during the harvest operations. The harvested material will be hauled to powerful expressors which will extract all of the latex from the plant.

IT DID NOT MAKE GOOD

The wild plant from Madagascar which is not all it was "cracked up" to be

Mr. Edison has given a roving commission to five traveling botanists and plant hunters to scour the Gulf Coast States and procure specimens of all the rubber-producing plants of that area. This quintet of camp-car rovers has roamed highways and back roads searching for strange unidentified plants in half a dozen different states. They have traveled exclusively by motor car, carrying with them provisions, camp equipment, and miniature botanical laboratories on wheels. Their scouting trips through thousands of miles of Dixieland forests, jungles, and cultivated fields have yielded the wealth of experimental material which Mr. Edison is now utilizing intensively.

Mr. Edison has centralized his experiments in southern Florida because investigations carried on by the United States Department of Agriculture and the Department of Commerce demonstrate that region to be the best adapted for rubber production of any section in the United States.

BAGGING TO PREVENT CROSS POLLENIZATION

In plant breeding it is necessary, in order to prevent bees from cross pollenizing plants with other plants, thus depriving the test experiment of its value, to exclude the bees with netting

A FEW OF THE 1200 EDISON TEST PLOTS

When investigating the possibilities of rubber plants, Mr. Edison followed the old Edison technique: to try systematically everything under the sun, rather than sit and wait for inspiration

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* At the time of going to press, news reports state that Mr. Ford has prepared several hundred acres for planting, with the expectation of a harvest in the late summer.

"How Do They Know?"

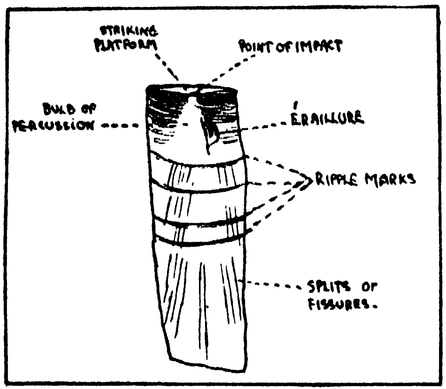
A Brief Glimpse of Some of the "Inside" Considerations Which Guide the Expert in Judging the Antiquity of Flint Implements

By J. REID MOIR

Fellow of the Royal Anthropological Institute; and Member of L' Institut International d'Anthropologie; President of the Ipswich Museum, England

IT is not so many years since the whole vast series of flint implements was divided up into two simple categories called Paleolithic and Neolithic, and prehistoric archeology was a more or less simple and straightforward subject. Now, not only has another and very important stage of ancient man's activities, the Eolithic, been added to the list, but in the case of the Paleolithic and the Neolithic phases these have been still further split up; and the process is not yet completed.

There are, however, still some archeologists of the older school who do not look with favor upon these modern methods of classification and who hold that though Paleolithic hand axes, for example, which are found in deposits of widely varying ages, must themselves be of a dissimilar antiquity, yet it is not possible to say that these implements differ from one another in the way they are made. Such critics would no doubt admit that the hand axes of early Paleolithic-Chellean times are more roughly flaked than are those of the later Acheulean period, but this admission would be qualified by the claim that while this difference exists it does not testify to any actual dissimilarity of technique in vogue in the two epochs mentioned.



All drawings by the author

FIGURE 1

A drawing of a humanly struck flake of flint, showing its various characteristics

This conclusion, however, is the outcome of neglect to make a close and enlightened study of the actual flake scars to be observed upon flint implements of different periods. When such an examination is carried out by anyone with the requisite knowledge based upon practical experience in flint flaking, it becomes at once obvious that the manner of production of flint implements differed at various epochs of the past as markedly and as certainly as did, for instance, the method of carving wood in later times. In fact, when those who are familiar with these matters are able to examine a representative series of implements of prehistoric industries the dissimilarity in technique of these is seen to be as well defined as is that between a carved oak chest of Tudor and of Stuart times.

There are, perhaps, few aspects of prehistoric archeology more fascinating that that which deals with the way in which flint implements were made, as it enables the modern investigator to realize precisely the manner in which the ancient artificer held and flaked his flint, and to understand how, usually with consummate skill, he produced the type of artifact needed.

THE importance of this recognition is further heightened when it is found that implements of the same prehistoric period, though found many hundreds of miles apart, exhibit an identical technique. But it is not possible to enter into the implications of this remarkable fact in the present article.

I am, however, anxious to bring home to readers of the SCIENTIFIC AMERICAN the reality of the dissimilarity to be observed in the method of manufacture of flint implements of different ages. It would be a matter of little difficulty to do this with the artifacts, for example, of the Chellean and the Magdalenian phases because these two industries—one belonging to the beginning and the other to the very end of Paleolithic times—differ from one another in the most obvious manner. I have, in fact, selected for examination two ovate hand axes, one of which is referable to the Chellean epoch, while the other belongs to the Acheulean which succeeded the former. Further, these two implements are very closely similar in size, form, and even in weight, for the Chellean specimen weighs 7 1/2 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 3/4 inches, while the Acheulean weighs 7 ounces, measures in greatest length 3 11/16 inches, and in greatest width 2 15/16 inches. Moreover, the Chellean example exhibits 42 flake scars while the Acheulean carries 57, and there can not, therefore, be any doubt that these two specimens are very similar to each other in several ways. Many people might regard it as impossible to demonstrate that the technique of each is different. Let us, however, examine these two implements still more closely and see what we can learn about them.

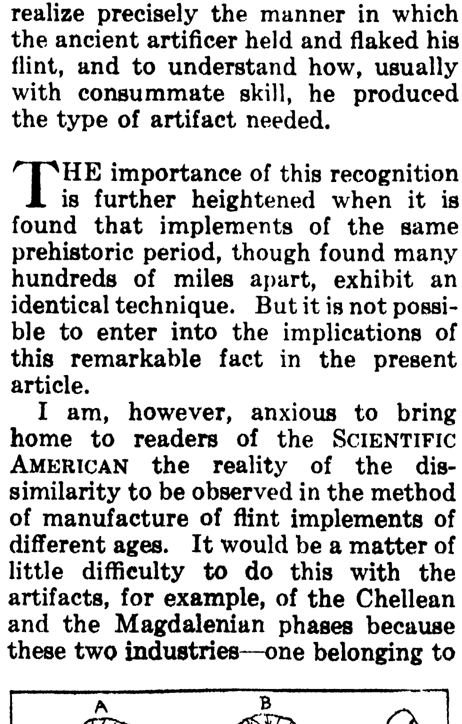


FIGURE 2, A and B

Two sides, edge, and horizontal section of a Chellean implement. Arrows show direction of the flake-removing blows

PERCUSSION FLAKING

Mr. Moir flaking an artifact, as photographed by a member of our editorial staff who visited his home in England

NOW, in order to do this it is necessary to prepare what are known as flaking diagrams of the specimens in which their general outline and that of the flake-scars is carefully drawn and arrows inserted to indicate the direction in which each flake-making blow was delivered. When a flake is struck off a flint by means of a blow, the fracture surface of the specimen usually exhibits several well-marked characteristics. For the purposes of this article it is only needful to draw attention, in Figure 1, to these characteristics, which are (a) the bulb of percussion; (b) ripple marks; and (c) the splits or fissures. The flake illustrated bears upon its fracture surface the "positive" bulb of percussion, while the flint from which it was removed exhibits a corresponding hollow known as the "negative" bulb of percussion. These hollows are often to be observed upon flint implements, while in nearly every case ripple marks and fissures are also present. As will be seen from Figure 1, the ripple marks have their concave side toward the point of impact where the flake-removing blow fell, while the fissures or splits also radiate from the same center. The recognition of these facts makes it easy, therefore, to ascertain from what direction each blow was delivered during the formation of a flint implement, and is the basis upon which the flaking diagrams accompanying this article were prepared.

If we now proceed to examine these diagrams it will be seen that the blows responsible for the formation of the Chellean ovate, Figure 2, A and B, were delivered somewhat less regularly around the periphery of the implement than is the case with the Acheulean specimen, Figure 3, A and B.

FURTHER, it is obvious that the forms of these flake scars differ in each implement, for the majority of these observable upon the Acheulean ovate tend to be long and narrow, while those exhibited by the Chellean specimen, no less definitely, tend to be short and broad. The reason for this difference is to be explained by the manner in which the ancient flint flakers held the flint while operating upon it with a hammer stone.

If it is desired to detach flakes which are long and narrow, it is necessary to hold the flint so that the fingers of the left hand are pressed against one side of the stone opposite to that upon which the blows are to fall. In Figure 4 the Acheulean ovate is held in the manner described, and the hammer stone would fall upon the flint just above the points of the fingers. The result of such manipulation will be that the detached flakes, for some reason, will run down under the fingers, and will more or less accord with their shape. Thus it is possible to say with a high degree of probability that the Acheulean man who made this particular implement actually held his flint in the manner shown in Figure 4, because the position and form of the flake scars on this specimen exactly resemble, both in form and position, those which can be produced today under the conditions described.

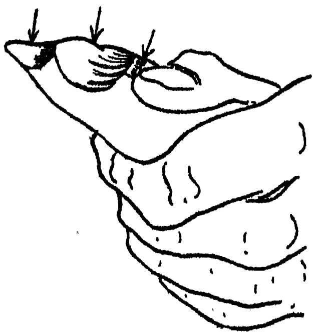


FIGURE 5

How Figure 2 was held. The arrows indicate where the blows of the hammer stone fell on the back face of the flint

When, however, it is needful to produce flake scars such as those exhibited by the Chellean ovate, an entirely different technique is adopted. In this case the flint is held firmly in the left hand, as shown in Figure 5, but the exact manner in which this is done does not matter. The hammer stone is directed first to one side of the edge and then to the other, and flakes are removed which, having no pressure of fingers or other support to influence their shape, assume a short and broad form.

The differences thus produced in the resulting implements do not, however, cease here. If the flake scars exhibited by the Chellean ovate are examined, it will be seen that while 12 of them are complete, no less than 30 are truncated or incomplete. On the other hand, in the case of the Acheulean ovate, the number of complete flake scars is 30, while 27 are truncated or incomplete. Thus it will be seen that the proportion of truncated or incomplete flake scars observable upon the Chellean ovate is very much greater than in the Acheulean example, and this is due almost entirely to the differing manners in which the two implements were made. A complete flake scar is one which has not been encroached upon by later flaking, while a truncated flake scar is one which has had its normal area reduced by the subsequent removal of other flakes.

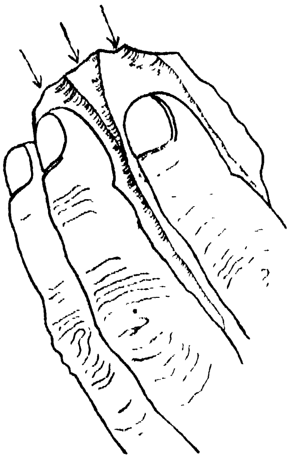


FIGURE 4

How the Acheulean flint was held. Blows fell on back side of flint, opposite the points indicated, producing long chips

Another clearly marked difference in the two implements under discussion is seen when their cutting edges are examined. In the case of the Chellean ovate, the edge is blunt and wavy, while in the Acheulean specimen, the edge is sharp and does not exhibit such a wavy outline. This dissimilarity is again traceable to the differing techniques adopted in the manufacture of the respective specimens.

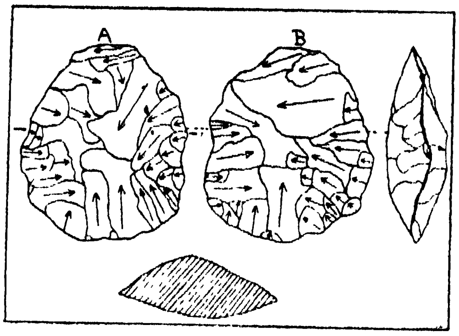


FIGURE 3, A and B

Flaking diagram of a typical implement of Acheulean age, one fourth of actual size. Arrows indicate where blows fell

It will thus be recognized that even in two implements closely resembling each other in weight, size, and the number of flake scars exhibited by each, there exist, nevertheless, fundamental differences in the specimens. These differences are the inevitable result of the manner in which the two artifacts were flaked and, being observable between most Chellean and Acheulean implements, serve to differentiate in a final manner the specimens of these two well-known prehistoric industries.

It is clear, also, that the two artifacts under examination have had different geological experiences in the past for, while the Chellean ovate is abraded and worn and exhibits upon its flake scars innumerable marks where other stones set in motion by rapidly running water have struck it, the Acheulean ovate shows few if any of such marks, and is very little abraded.

THIS difference in condition is generally to be seen between implements of Chellean and of Acheulean age from deposits of gravel both in England and as far away as Palestine. It points, unquestionably, to some drastic climatic conditions having occurred after the Chellean industrial phase, and through the researches carried out in East Anglia in England, it is now known that these conditions are to be associated with the second glacial epoch.

It is upon such lines as have been indicated in this article, that modern archeological research is moving, and in so doing is hastening the time when this study will take its place among the exact sciences. The method of examination of flint implements which I have here described is, however, but one of others which are being carried out at the present time, and these I hope to be able to describe on some future occasion.

¶ *We have on hand and expect soon to publish another of Dr. Paul R. Heyl's uniformly lucid articles, entitled "Is there an Ether?" The recent experiments of Dr. Dayton C. Miller have reopened this subject.*

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

A Mail Order Airplane

E. B. HEATH of Chicago has been building and flying airplanes since 1908, mostly of the low power or "flivver" variety. The opinion is often expressed that what aviation needs is a reliable, cheap airplane which can be purchased for a few hundred dollars. Perhaps the Heath *Parasol* is what is needed. At any rate, fully equipped and ready to fly, it costs less than 1000 dollars. All the parts, minus motor, can be bought for about 200 dollars. A small engine of under 30 horsepower can apparently be bought for about the same price. Blueprints can be purchased for a few dollars. The circular states that the *Parasol* can be constructed by the home-builder using a limited supply of tools!

We do not know whether it is advisable to have airplanes built at home, without Government license, even though they can be flown privately without a license. Nor does the circular from the company state whether the *Parasol* has a type certificate for the original model.

The *Parasol* has the following characteristics:

Span, 25 ft; chord, 4 ft. 6 in.; wing area 110 sq. ft.

Overall length, 16 ft. 9 in.; height overall, 5 ft. 10 in.

Weight empty, 260 lbs.; useful load, 300 lbs.

Gas capacity, 5 gallons.

High speed, 70 m. p. h.

Cruising radius, 200 miles.

Engine, Henderson converted motorcycle engine.

Our photographs give a very good idea of the trim little craft equipped as a seaplane, though otherwise not modified from its land conception. There is no reason why a good flier should not feel perfectly comfortable and happy in it. The short exhaust stacks should not be much of a handicap, in view of the low power involved.

The little seaplane can be readily handled and launched by one man.

While we would like to have more engineering information, we do think that this is a very interesting small plane which may do as much to foster aviation as the huge tri-motor at the other end of the scale.

Glider Carnival Trophies

CONTINUING its traditional support of aviation, and to aid the spread of interest in one of the fundamental branches thereof, the SCIENTIFIC AMERICAN has offered a cup and second prize in Event Number Two, "Duration of Flight in the Primary Training Glider Event for Third Class Glider Pilots" to be competed for at the New York Glider Carnival in Bayside, Long Island, to be held April 25 and 26. Miss Amelia Earhart is chairman of the trophy committee and the women's events.

Considerable enthusiasm has already been aroused in this coming carnival and many prominent novices, as well as more experienced gliders will take part. The SCIENTIFIC AMERICAN will follow the developments and Professor Alexander Klemin, who is a member of the General Committee, and one of the Official Timers for the meet, will write a summary of the aeronautical advance and tell what deductions can be made therefrom.

Air Commerce in 1930

THERE is a depression in American aviation at this moment which is causing the industry much searching of heart. The article in the *Air Commerce Bulletin* which begins with the question "What is the outlook for commercial aeronautics in 1930?" is therefore very timely.

During the last three years, civil aviation has experienced tremendous growth. Air-transport planes fly on schedule almost 90,000 miles per day, yet these scheduled operations constitute only 15 percent of the total flown in the United States.

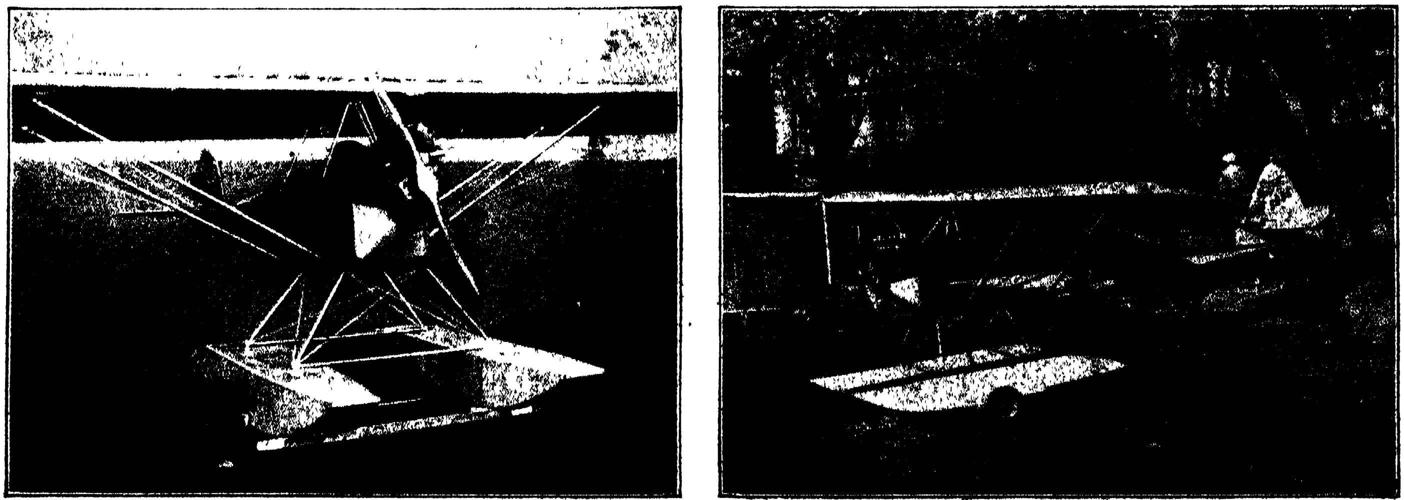
All phases of commercial aeronautics continue to grow at an average rate of 60 percent per annum. The expansion has been particularly marked during the last 18 months.

In this period of hasty development, a great number of new manufacturing facilities have been made available without reference to the consuming capacity of the market. Money has been forthcoming readily for financing, so readily in fact that marketing problems have been virtually forgotten. In air transport, on the other hand, the ample capital provided has on the whole been put wisely to work, and there is no excess. The operators have just enough money to meet the difficulties of getting passengers to fly, of perfecting their organizations, of securing safe operations, and so forth.

It is therefore mainly from the manufacturing point of view that depression has come upon us. It is to be expected that this depression will disappear in the course of a year or even less. Some of the weaker units will vanish via a receivership; others will merge; more powerful manufacturers will revise their production figures and gradually dispose of accumulated planes. While the manufacturers are retrenching at one end, the industry on the other hand will be constantly expanding and providing a larger market.

The *Air Commerce Bulletin* gives the following very encouraging statistics:

During 1929 approximately 16,000,000 miles were flown in scheduled operation as compared with 10,673,000 in 1928. Eighty

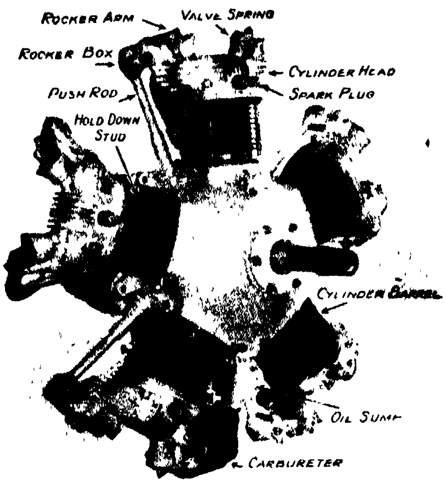


Two views of the tiny Heath *Parasol* monoplane, equipped with pontoons and powered with a small four-cylinder air-cooled motor. This plane is also available with a wheeled landing gear for land operation

five thousand passengers and 8,000,000 pounds of mail were transported in 1929, as compared with 49,000 passengers and 4,000,000 pounds mail in the previous year. Miscellaneous flying has shown at least an equal rate of growth. In 1926, miscellaneous flying totaled 18,000,000 miles; in 1927 it rose to 30,000,000 miles, and in 1929 we have the astounding figure of 125,000,000 miles.

Inside an Aircraft Engine

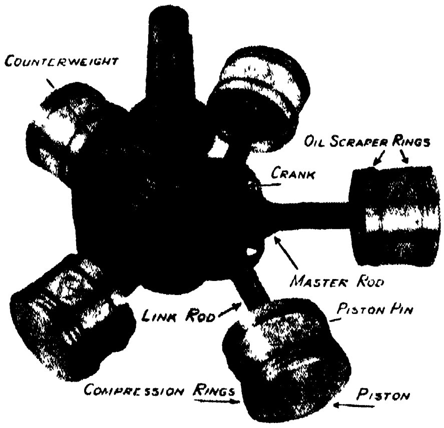
OUR photographs of the Lambert R-266 aircraft engine are quite instructive. This is a 90-horsepower, five-cylinder air-cooled motor with a speed of 2375 revolutions per minute, yet it weighs only 214 pounds, and is well adapted for a training plane or a sportsman's two-seater. It has rather a large bore (4.25 inches) and a short stroke (3.75 inches) which helps to make its frontal area compact.



Refer to the front view: The Y metal cylinder heads (which retain their strength at high temperatures) are seated on a nickel-steel cylinder barrel, with a copper-asbestos gasket between cylinder and barrel. Four long studs screwed into the crankcase hold the heads down. The barrels can be replaced separately. It is interesting to see how generous modern aircraft engine designers are of fin area. Cooling fins embrace the whole of the barrel and head. The valve rods and overhead valves and rocker arms are neatly enclosed. There are no accessories in front of the engine. This enables the plane designer to fit a smooth cowling over the engine.

Lightness is the keyword in aircraft practice; accordingly the crankcase is made of heat-treated magnesium alloy. It is split on a plane through the cylinder centers with valve lifters and intake passage in the rear.

The intake ring is inside the crank case, and leads the gas from a single carbureter to all five cylinders. Distribution of gas is helped by partial baffling inside the rim between two of the cylinders.



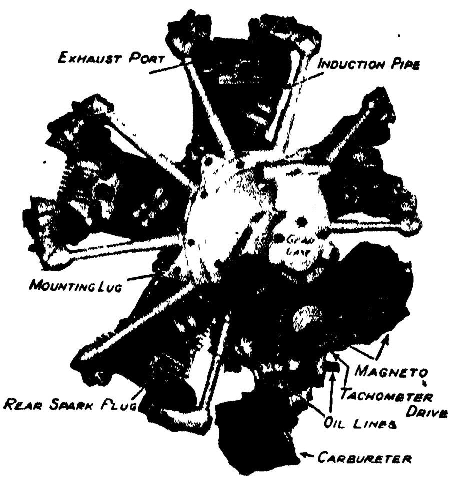
Upper right: **Rear view of the Lambert engine described in the text.** ***Above:*** **Piston, connecting rod, and crank assembly.** ***Left:*** **Front view of the same radial engine**

The gear case at the rear is also of magnesium alloy. A compact set of gears working from the main shaft drives the valve gear, two magnetos, and the lubrication pump.

A single master connecting rod works on the crankshaft, with other connecting rod ends working in the master.

A Flying Wing

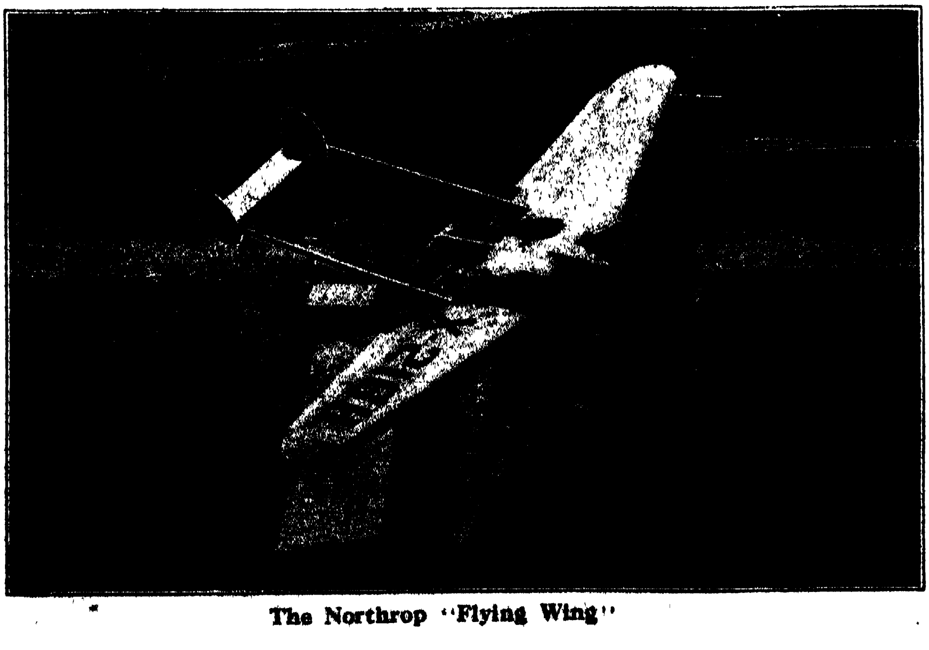
A NEW plane, secretly developed and flown by the Northrop Aircraft Corporation of Burbank, California, approaches closely to the ideal "flying wing" and with an engine of only 60 horsepower has flown at a speed of over 100 miles per hour.



The wing itself, 30 feet in span, is internally braced, with not a single exposed brace. It is quite thick at its center, thick enough, in fact, to contain a comfortable cockpit. There is no fuselage, the tail surfaces being supported by two long streamlined outriggers running from the wing. A four-cylinder inverted air-cooled engine, carefully cowled in, projects from the forward center of the wing. The "pusher" propeller is placed at the rear and is driven by a long shaft extending from the rear of the engine. Since it is not convenient to carry a tail skid or tail wheel on outriggers, a three wheel landing gear is placed under the wing, with the rear wheel steerable for taxying on the ground. The center rear wheel is somewhat nearer to the wing than the others, so that a suitable low-tail landing attitude can be readily assumed.

Besides the internal bracing of the wing, the two factors tending to increase efficiency are: one, the disappearance of the fuselage and the hiding of the pilot in the wing; two, the use of a "pusher" propeller, which interferes less with the flow over the wing, and the slipstream from which meets fewer parts, so that resistance here is reduced.

There is no doubt that the design constitutes a decided step forward in aerodynamic efficiency. It is creating much interest in aviation circles and its progress will be carefully watched.



The Northrop "Flying Wing"

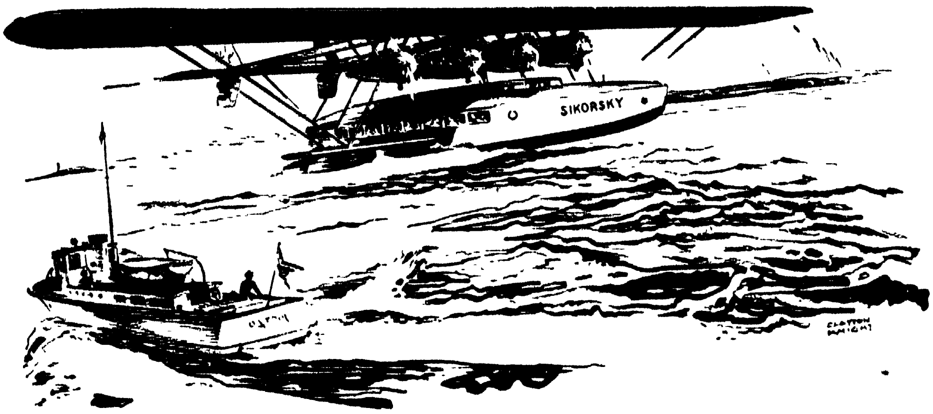
An Interesting Amphibion

A PROJECTED Sikorsky amphibion, the *S-40*, which follows on the heels of much service experience with the now famous Sikorsky *S-38* is shown in the accompanying artist's sketch. The design of the *S-40* has been carried out with care and has been thoroughly tested in the wind tunnel and the model basin.

If passengers are to make long journeys, such as from New York to Buenos Aires by air, they must be comfortable. Therefore the design provides for large passenger compartments, large windows with unobstructed vision, perfect ventilation, roomy toilets, washrooms, and kitchen and permanent quarters for the crew.

A flying boat must not only be satisfactory in the air; it must also incorporate the sound principles of surface vessels in the matter of marine equipment. The *S-40* can be towed from the bow; davits are provided in the front marine compartments; cleats for mooring a launch are available. A walk-way is provided along the lower structure to the pontoons. A hoisting sling allows the entire ship to be hoisted on a beam. To give seaworthiness, large excess buoyancy for the hull has been provided.

Power plant reliability is paramount for passenger service. The four engines insure reliability, because the plane can fly on full load with any one engine out of commission, as long as the fuel holds out. Also, storage space and hoisting arrangements are to be provided for carrying a spare engine. The fuel tanks, located in the wing to give gravity feed, have capacity for four hours' flight. The remainder of the fuel is carried in tanks located on top of the side floats. Cross feed valves will permit any engine to be supplied from any tank.



An artist's conception of the projected Sikorsky amphibion, *S-40*

In the construction of the hull, drainage has been provided from all parts. There are five water-tight compartments, any two of which will keep the ship afloat; the gas tanks provide emergency flotation.

In the positioning of the power plant, certain definite principles have been kept in view. Thus no part of the passenger or crew accommodations are in the plane of rotation of the propellers. The engine nacelles are so located with reference to the wing that there is a minimum of interference between them and the wing. The propeller clearance is 80 inches from the water, an important item when we consider the spray and rough water a flying boat has to encounter.

These large flying boats are to be built entirely of dural except for the fabric covering of the wings. Corrosion has to be taken into consideration. The high position of the wing above the water is a help. The use of the non-corrodible metal Alclad in covering the hull is an important feature.

The outriggers for carrying the tail surfaces run from the high wing, so that the tail surfaces are well above the waves. The structure follows the well tried Sikorsky principles.

The specifications of the new craft are to be as follows: Wing spread, 114 feet; chord, 192 inches; overall height, 22 feet 11 inches; over all length 72 feet 11 inches; wing area, 1980 square feet; power plant, four Pratt and Whitney Hornets, B, with a total horsepower of 2300; useful load, 11,250 pounds; high speed, 129 miles per hour; cruising speed, 108 miles per hour; climb, 675 feet per minute; stalling speed, 65 miles per hour.

A Mobile Weather Bureau

SIMULTANEOUSLY with advances in communication between airplane pilots and the ground, our large air transport companies are developing their weather services to the fullest extent. For example, the meteorologists of the Transcontinental Air Transport—Maddux Air Lines give the pilot, in advance of each flight, reports showing the location of storm areas, the direction and speed of their movement, regions of low ceiling and poor visibility, and areas of low pressure.

In addition to the regular meteorological equipment, new equipment has been added consisting of small rubber balloons, a special inflation device, and hydrogen tanks. These additions have been made in order that observers may gage accurately the height of low hanging clouds so prevalent in winter months, and the direction and velocity of winds at higher altitudes.

The Boeing Air Transport system is equally awake to the importance of weather service and has provided something of an innovation in the form of a "mobile" weather bureau. In addition to meteorological equipment the mobile bureau is equipped for radio transmission, with an aerial mast attached to the automobile.

A Minimum Altitude

TRANSPORT planes have heretofore been required to maintain a minimum altitude of 500 feet except when forced to fly lower by exigency of the weather. As a result of the T. A. T.—Maddux Air Lines crash, which led to the death of 16 passengers, the Department of Commerce has issued a new ruling. By this ruling, if a plane is forced to fly under 500 feet, under any circumstances, it must alight at the nearest possible landing place and do that as quickly as possible. This may effect a hardship on those operators wishing to maintain a schedule in conditions of low ceiling. Nevertheless, the rule should lead to safety, and safety is paramount.

Lindbergh Buys a Plane

IN spite of the fortune that he has undoubtedly accumulated, Colonel Charles A. Lindbergh remains as busily at work as ever, rendering consulting service to the most important air transport companies in the country. He has just purchased, paying over 17,000 dollars, the fastest two-seater sport plane ever built, the Lockheed *Sirius*, constructed by a subsidiary of the Detroit Aircraft Corporation.

In its coloring Lindbergh's new ship is distinctive. The entire fuselage is black and has a wide gold stripe along the mid section of each side. The wings, extending from the lower side of the fuselage, and the tail surfaces, are painted red.

The Lockheed engineers designed the new plane in consultation with Colonel Lindbergh. It has some very interesting characteristics.

To begin with, the plane is the last word in streamlining. The wings are internally braced, without the slightest exposed bracing. The fuselage is an almost perfect streamline and blends into the wings. The cowling, of the Venturi type, encloses the engine and reduces head resistance, yet allows perfect cooling. At the front there is a wide opening allowing plenty of air to impinge on the engine. But this air passes out through an opening at the rear which closely embraces the fuselage. Hence the air is not widely disturbed but follows the lines of the fuselage in streamline form. The wheels are almost entirely enclosed in special streamline housings, commonly termed "pants."

A Pratt and Whitney Wasp engine is employed, developing 425 horsepower at 2000 revolutions per minute.

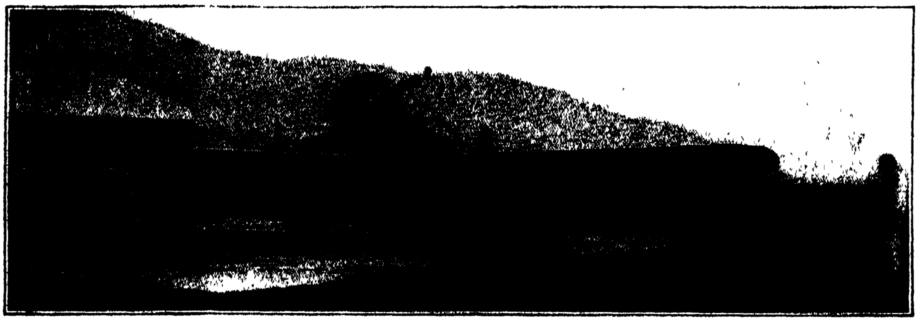
The two cockpits, which Colonel and Mrs. Lindbergh will occupy so often, are located well to the rear of the fuselage so as to give maximum protection in a crash.

The wings of the plane have a span of 42 feet 10 inches, and their area is 265 square

The mobile weather bureau in operation in the field

feet. Weight empty is 2950 pounds. For average use, the useful load is: 150 gallons of gas, 12 gallons of oil, pilot, passenger, parachutes, and baggage. The gross weight with this load is 4400 pounds.

Lindbergh desired a possible range of 3300 miles; therefore 320 gallons of gasoline may be carried in the fuselage, and 120 gallons in the wing. The plane will certainly be fast, even though performance data are not issued to date.



***Above*: Colonel Lingbergh's new plane with cowled air-cooled engine.** ***Below*: The *Sirius* in flight**

Details of a French Catapult

MANY authorities believe that sooner or later airplane catapults will be used on all ocean liners carrying international mail, and that they may even be brought into service for launching heavily loaded land planes at airports of restricted size. We do not believe that the use of catapults in land operations will ever be found necessary, but see no reason why their use should not become general in liner service.

The United States Navy has developed catapults to as high a degree of efficiency as any other organization but the navy is somewhat chary, and rightly so, of disclosing full details of its apparatus. Details of the French system "Penhoët," as employed on the *Ile de France*, and described in *L'Aeronautique*, are therefore of real interest, particularly as the Penhoët system seems to be well worked out and reliable.

In Figure 1, the seaplane, 5, has its float or hull mounted on the chariot, 3. To the front end of the chariot is attached a cable, 12, which passes over a large pulley, 8, placed at the end of the runway. The cable then passes over a system of six pulleys. The pulleys to the right are movable and mounted on a rod which is rigidly attached to a piston in the compressed-air motor, 2. The motor is actuated by a great volume of compressed air contained in the cylinder, 1. There is, between the cylinder and the compressed-air motor, a valve, 9, which can have its air outlet regulated by the mechanism, 10. The value of this regulating valve is that it allows the chariot to be launched with constant acceleration and with a well defined final velocity—important factors for the efficiency of launching and the comfort and safety of the pilot.

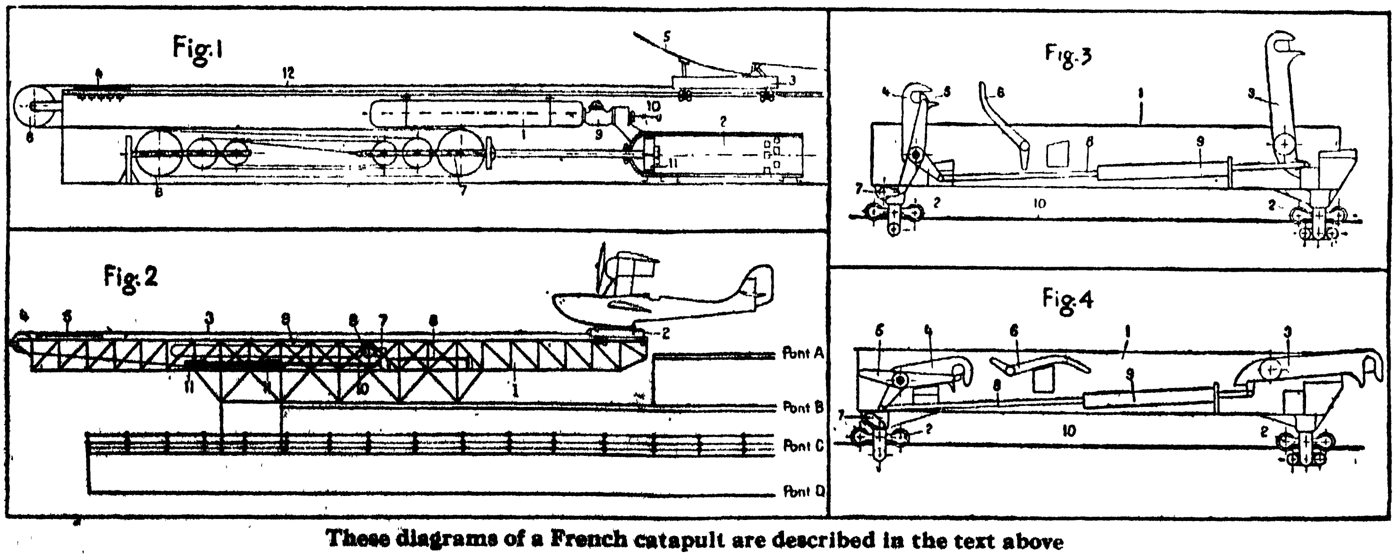
The chariot itself is a metal structure which must be very light so as to have the minimum inertia, and quite strong because of the large and peculiar forces involved.

Figure 2 shows the general arrangement of the system. The truss, 1, is a huge, solid structure mounted on the C and B decks of the *Ile de France*. The chariot, 2, is mounted on suitable rollers. The compressed air cylinder, the compressed air motor, the cable and the pulley system are all mounted within the truss, in a manner which is immediately intelligible from the diagram.

Figure 3 shows details of the chariot mounting when in process of being launched. Figure 4 shows the mechanism when the brakes are applied at the end of the run. The seaplane is held some four inches above the chariot, being suspended at the ends of the hooks, 3 and 4. At the end of the run, when the seaplane leaves the chariot by inertia effect, it actuates the trigger, 6. The trigger releases a spring, 9, which in turn brings down the hooks, and applies the brake, 7. The action of the brake is regulated also by compressed air. The deceleration of the chariot is about 15 to 20 times gravitational acceleration.

It would appear that in practice the pilot can stand an acceleration of some three times that of gravity. On the commercial steamship where space is not at such a premium as on a warship, the catapult can be 100 feet or more in length and the acceleration in launching can be less. The plane can be launched at an air speed a few miles higher than the minimum flying speed without any difficulty. For reasons of space, the *Ile de France* had its catapult mounted at the stern.

Theoretically the catapult should be mounted at the bow. The speed of the seaplane, relative to the air, is then equal to the speed of the ship plus the speed of the chariot and the acceleration relative to the ship and all the forces involved are much smaller. In the design of new ocean liners, naval architects will probably have these considerations in mind.



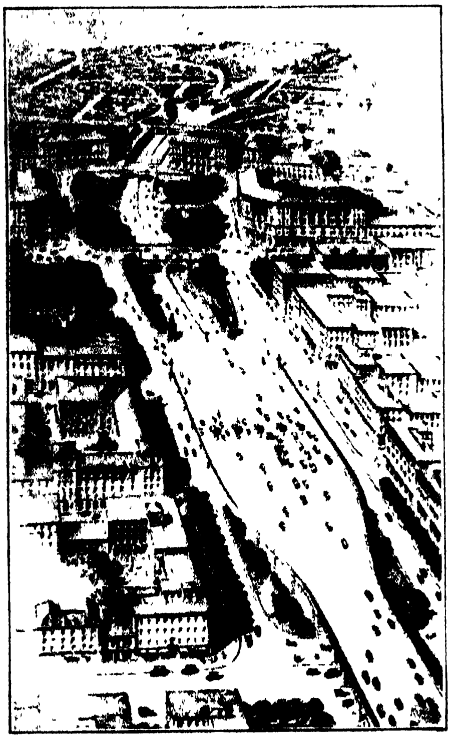
These diagrams of a French catapult are described in the text above

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Hudson River Bridge Approach

TRAFFIC handling methods of an advanced nature have been introduced in the approach arrangements of the new Hudson River Bridge between Fort Lee, New Jersey, and West 179th Street, Manhattan.



Plan of the New Jersey approach to the new Hudson River Bridge

No intersecting crossings at grade and no left-hand turns feature the scheme for expediting the movement of vehicles to and from the bridge. The plan of traffic distribution also seeks to accommodate motor travel without stops for lights or other signals. A handful of traffic men, it is declared, will be able to take care of the entire flow of traffic. The scheme is capable of handling the ultimate capacity of the bridge. Four lanes of traffic are contemplated initially.

In discussing the approach innovation, Frank C. Ferguson, vice-chairman of the Port of New York Authority, commented: "The Port Authority has discarded the old circular plaza idea, which lent itself to civic planning but throttled motor vehicle performance. Such plazas, which then adequately served their purposes, are now a relic of the horsedrawn vehicle days with speeds of 10 miles an hour. American cities having circles or circular plazas today are either confronted by a traffic tangle, as exists at Du Pont Circle in Washington, or are discarding the circular movement of traffic as has been done at Columbus Circle, New York. Berlin has a similar problem at Belle Alliance Place. Traffic distribution must be as definite as the routing of railroad trains, with definite paths of travel in both directions."

The Fort Lee approach arrangement shows that direct access will be afforded to Hudson Terrace. The latter, which will be crossed by an overhead structure, is the first intersecting street in Fort Lee after one leaves the span itself. After passing over Hudson Terrace, the bridge approach will continue to rise until a broad, level traffic distributing point will be reached, from which northbound connections will be made with Lemoine Avenue.

Continuing, the bridge approach will pass under Lemoine Avenue and then distribute and collect southbound Lemoine Avenue traffic. Direct access also will be given to Center Avenue. The bridge approach will underpass Center, Linwood, and Fletcher Avenues. The Public Service Railway's right of way east of Center Avenue will be maintained without a grade crossing.

At Fletcher Avenue, a distributing basin is reached for State highway routes numbers 1, 4, and 6, the Bergen Boulevard, and County Road.

The entire bridge approach from Hudson Terrace to Fletcher Avenue will be flanked by marginal streets in order that local traffic may be accommodated without interference with bridge and through route traffic. The maximum grade will not exceed 4 percent, except on certain secondary connections where this rate will be somewhat higher, but well within motor operating conditions.

German Locomotive Has 1700-Pound Pressure

THERE had just been completed at the Berliner - Maschinenbau - A. G., formerly L. Schwartzkopff, a passenger express locomotive employing the unprecedented working pressure of 1700 pounds per square inch at 900 degrees, Fahrenheit. The new locomotive was manufactured by the aforementioned firm in closest co-operation with experts of the German railways. Its weight was kept within the limits prescribed for the standard locomotive. Test runs will be made in the near future and the locomotive will be exhibited at the World Power Conference in June.

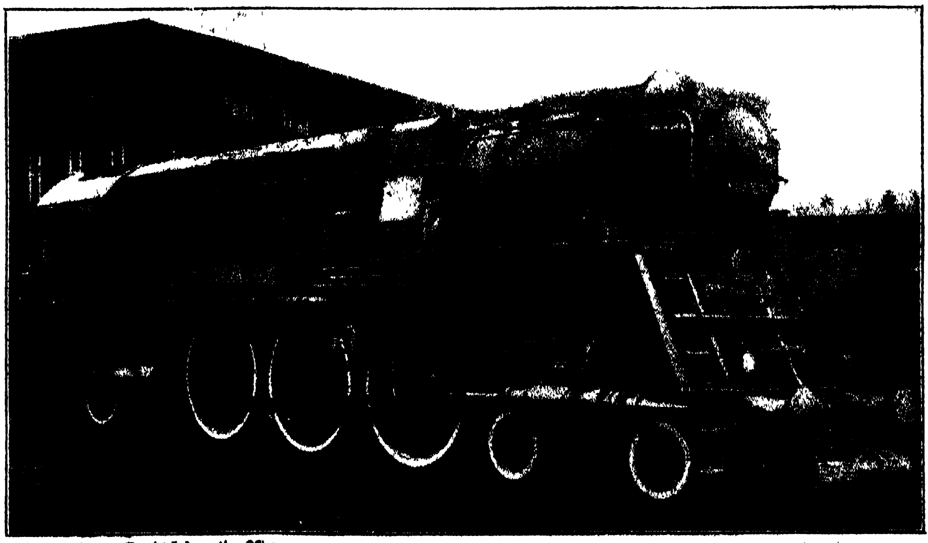
The new and unique method of generating high-pressure steam employed in this locomotive was developed by the late Prof. Dr. Löffler. It is claimed that it may prove especially successful in connection with locomotives because it overcomes the problem of the formation of "fur" within the boiler in a very simple manner, and its fuel economy is very high.

The characteristic feature of the method is that water is evaporated in a non-heated boiler drum. This drum receives heat indirectly from the grate by means of superheated steam. The high temperature of the heating vapor is transferred to a superheater, the heating surfaces of which are not subject to the formation of "fur." The locomotive factory in Wien-Floridsdorf proved the practicability of the method by applying it in a small stationary test arrangement, before the order for the locomotive was given.

World's Largest Underwater Tunnel

WORK is now going forward on a single-tube vehicular tunnel under the Mersey River to connect Liverpool and Birkenhead, England, which will have a total length of 2.16 miles and an interior diameter in the underwater section of 46 feet 3 inches. The tunnel will carry four lines of vehicles abreast, with ample space for ventilating air ducts. Although the tunnel cross-section shows a space beneath the roadway for street cars, these have not been definitely decided upon.

Plans for improving communication between the two boroughs have been under consideration for more than three quarters of a century. In 1922, a committee of three engineers was appointed to make a study of the problem and to report upon the feasibility of improving facilities for cross-river traffic by means of a bridge or a

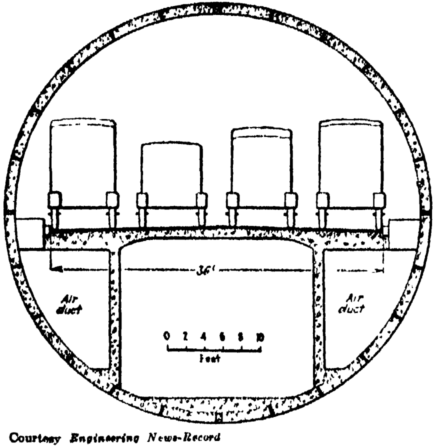


Courtesy German Tourist Information Office

The locomotive employing high pressure steam, which has just been completed in Germany. Note its very small cylinder and construction features

tunnel. After an exhaustive study, these engineers reached the unanimous conclusion that a tunnel would best meet traffic requirements. Accordingly, after approval of the plans had been secured from parliament in 1925, work was started in that year on the driving of a preliminary tunnel along the line of the future main tunnel to explore the ground. The two headings of the preliminary tunnel met beneath the middle of the river in April, 1928, and shortly thereafter a contract for the enlargement to full section of the underwater portion was awarded. The approaches in Liverpool and Birkenhead were awarded on separate contracts in November, 1928, and March, 1929.

Double approaches are provided on both sides of the river. The 36-foot roadway used in the underwater section is continued throughout the main approaches on each side and, in addition, branch approaches from sections near the riverfront are provided with roadway widths of 18 feet, accommodating two lines of traffic. Roadway gradients are, for the most part, 1 in 30, with a maximum of 1 in 29.4 on the Liverpool approach. The usual cast-iron lining is to be used, sealed with concrete grout and concrete on both exterior and interior.



Courtesy Engineering News-Record

Cross-section of the Mersey River vehicular tunnel, showing space which may be used for street cars

Ventilation will be taken care of by three plants on each side of the river which will supply a total of nearly 4,000,000 cubic feet of fresh air per minute. It is expected that the maximum proportion of carbon monoxide will not exceed 4 parts in 10,000. The system of ventilation to be used has not been definitely determined; studies are now being made of the relative advantages of transverse and longitudinal ventilation.

Present plans call for completion of the tunnel in June, 1932, at an estimated cost of approximately 25,000,000 dollars, of which the English government will contribute over 12,000,000 dollars. The balance of the cost will be met by loans, secured by toll charges to be maintained for a maximum periods of 25 years, and also by funds to be provided by the two cities. – *Engineering News-Record*

Glass Resists 15-Ton Pressure

A BIT of glass about a sixteenth of a square inch in area bearing a load of approximately 15 tons, is the simple new weapon of science developed by Professor Thomas C. Poulter of Iowa Wesleyan University.

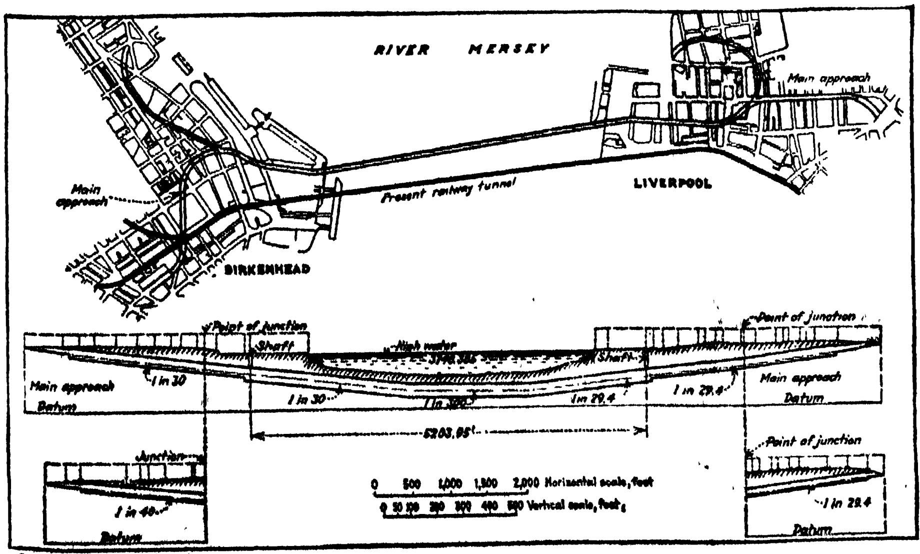
It served as a tiny window looking into a pressure-chamber, where experiments are performed under the tremendous pressure of 30,000 atmospheres. The little glass window is ground perfectly flat and set against a ring of high-speed steel, also ground perfectly flat. There is no gasket; the pressure attends to the sealing of glass against metal. – *Science Service.*

Zinc Treatment Kills Weed Seeds Without Injuring Sprouting Trees

A METHOD of chemical weeding for seedling beds of evergreen trees has been worked out at the Northern Rocky Mountain Forest Experiment Station of Missoula, Montana. According to W. G. Wahlenberg, formerly of the United States Forest Service, who describes the work in detail in a new technical publication of the United States Department of Agriculture, this method saves 27 percent of the cost of producing two-year-old tree seedlings, besides saving many young trees that would be destroyed or damaged by the old laborious process of hand weeding.

The new method, as worked out during several years past at the Savenac nursery, consists in applying one and one eighth ounces of zinc sulfate dissolved in one quart of water to every four square feet of seedbed soil. This attacked and poisoned the roots of the weeds as they tried to leave the germinating seeds. The roots of the sprouting evergreens were more resistant and were not injured. The situation was roughly analogous to that in the blood of a malaria patient who takes quinine. The drug kills the germs but does not harm the body tissues.

In a clay pit at Woodbridge, New Jersey, footprints of dinosaurs were found in January and others have been found since then. The photograph shows scientists at Rutgers University examining one of the prints in a cut-out block of the clay



Courtesy Engineering News-Record

Plan and profile of the vehicular tunnel connecting Liverpool and Birkenhead, England. It will be larger in diameter than those in this country

During the experiments, other chemicals were tried, but zinc sulfate proved to be the most effective. Higher and lower concentrations of the zinc sulfate were also tried, but the higher concentrations sometimes injured the tree seedlings, and the lower ones were not so effective against the weeds. The concentration to be used for best effect must depend partly on the nature of the soil, Mr. Wahlenberg says. A finer-grained soil than the one at Savenac would require more of the sulfate, a coarser-grained soil less.

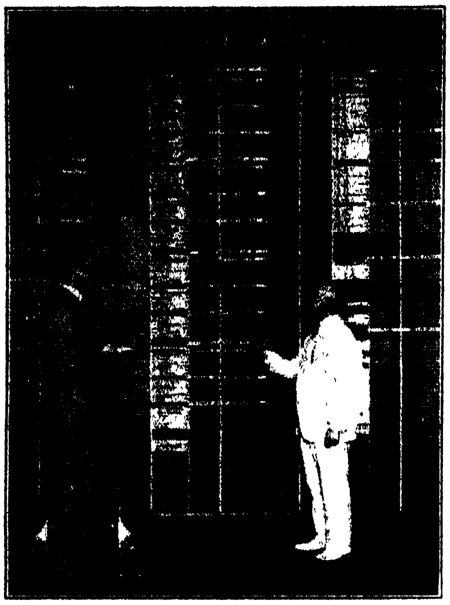
The method is not without its disadvantages, which must be guarded against. The sulfate tends to make the soil acid, and liming will be necessary in some localities to correct this. If the soil is stirred after applying the sulfate to the surface, the effect is lost; weeds sprout readily in spaded or plowed places after treatment. Fresh treatment of a seed bed is therefore necessary every time a new lot of tree seeds is planted.

One incidental advantage seems to come from the treatment. After the seedlings are taken up and the soil re-plowed, field peas are frequently planted as a green manure crop. The residual zinc in the soil does not injure the peas but rather increases their growth, apparently through encouraging the colonies of nitrogen-fixing bacteria on their roots. – *Science Service*

Huge Steel Balls to Carry Helium

SIX huge steel balls mounted on a flat car to appear on American railroads soon will not be globes consigned to a mammoth pawn shop, but efficient containers for precious helium to carry the gas from Texas oil fields to distant airship hangars.

When tested at Milwaukee recently, one of these six-foot spheres, made of steel an



A glance at this chart tells officials of the Navy the location of any vessel of the fleet: It is revised as ships are re-assigned or travel from port to port over the world

inch and a half thick and mounted on a flat car, was filled with helium at 1250 pounds per square inch pressure and run off a 25-foot bank. It was unharmed. It finally exploded under a pressure of 4500 pounds per square inch.

The odd-shaped container is used because it can carry twice as much gas as a cylinder of the same volume. That sounds contradictory, but because of its spherical shape, double the pressure in the cylinder is required in the sphere to stress the steel equally. Consequently at double pressure the sphere will hold double volume.—*Science Service.*

"Sub-Soiling" Deep Tillage

For unknown thousands of years man has scratched the surface of the ground before planting his seeds. The power for this work was the strength of his own back, the implements were a forked stick or a pointed heavy limb. Then the horse was domesticated and he did the work for ages. The farmer of today has the power of a tractor. How shall he make the most of that power? By deeper plowing? Possibly—but there is another way.

A new technique of soil tillage has been developed in the semi-arid areas of the Pacific Coast states. It has been found that the tractor may be put to profitable use for stirring and breaking the hard packed sub-strata of soil without turning them to the surface. This has been called "deep tillage," and "sub-soiling," but the word "subbing" is a short, descriptive phrase for this improvement in agricultural practice.

"Sub-soiling," done either by tractors with specially constructed implements called sub-soilers, or by blasting with dynamite, is an operation by which a hard stratum of a sediment, at many places of an almost rocky nature, is broken up and is made permeable to water. The latter, by its physical and chemical action, will disintegrate that stratum, so the roots of plants may penetrate it and obtain from it and also from the soil beneath it, the necessary plant food. A study of the results of experiments in subbing compels one to the belief that it is generally well worth the cost to rid field or orchard or vineyard of this stratum of impervious soil that limits the productive depth of the farm.

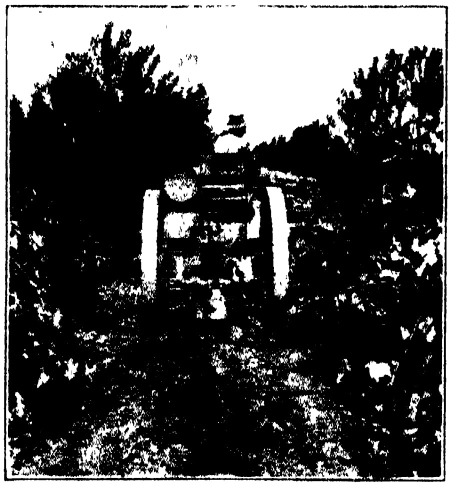
Subbing, as practiced in California, is usually associated with a complete system of tillage, particularly in orchard districts. The sub-soiler is used in the fall—when the soil is dry—after which the soil is prepared by cultivation for the green-manure crop. A leguminous cover-crop is raised in the winter or early spring.

Instead of turning under this cover-crop with the plow, so that the vegetation is buried under a heavy layer of earth, those who favor deep tillage employ a heavy duty tractor disk harrow of special type, to chop the cover-crop and mix it thoroughly with the surface soil.

In preparation for irrigation, a heavy duty "chisel" cultivator is employed to stir the soil to a considerable depth. To this are sometimes attached "crowders" or furrowers to make the irrigation ditches. No plowing is done.

A prominent western authority on tillage and soil management recently made the rather startling prediction that within a few years in many districts, the new system would make the plow obsolete.

The foundation of the deep tillage system is the "subber," or sub-soiler, a sturdy implement carrying one, three, or five standards, depending upon the depth to which it is desired to subsoil, and upon the power available for sub-soiling to that depth. These standards are composed of a stout metal shank to which is usually attached a renewable chisel-like tooth. This is sunk into the ground beneath the stratum of under-crust, and is customarily pulled by a stoutly-built tractor that is generously powered. It cuts to a depth of 12 to 30 inches, although special outfits may go as deep as 40 inches or more. The sub-soiler is pulled only when the ground is dry and more readily fractured, and the ground is thus shattered to a considerable distance on each side of the standard, the exact width of the effective work varying with the depth of the blade and the type of the soil.



Sub-soiler in operation in a vineyard. The sub-soil is loosened but the surface soil is hardly broken

The chisel cultivator is stoutly built. This stirs the soil without turning it up. To the frame are sometimes attached right and left moldboards. These may be used to form a furrow in which fertilizer can be placed, these moldboards being reversed on the second passage over the ground to cover the fertilizer.

The chisel cultivator is especially favored for field crops. Although it does not work as deep as the sub-soiler, it is effective in the destruction of plow-pan. This implement is now being used successfully by many grain growers in place of the plow. Users generally agree that this method is cheaper than plowing. Some farmers, however, state that the cost of the two methods is about the same. The heavier chisel-cultivators will work at a depth of 12 inches.

The disk harrow is a tool widely used by advocates of deep tillage—ordinarily being of heavy and sturdy construction. One of the larger, heavy-duty implements has 44 disks (20 or 22 inch) and weighs more than a ton.

The furrower is a light, V-shaped device attached to the shank of the chisel cultivator and sometimes is called a "crowder." The furrower makes an extremely deep furrow and a very narrow one. Measured from ground level, the furrow seems about 14 to 16 inches deep, to say nothing of the way the sides are built up by the soil thrown out, and only about a foot wide at the top. Therefore, when irrigation water is turned into a furrow like this it goes deep and leaves the surface of the ground dry. Loss from surface evaporation is reduced and the very harmful effect of hot sun shining

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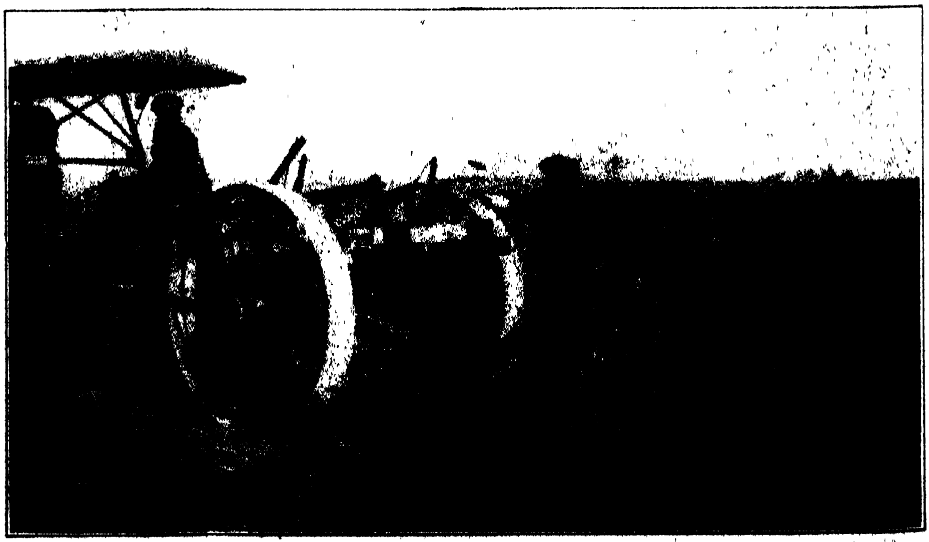


The sub-soiler equipment is useful also for uprooting the matted and gnarled roots of old worn-out vines when necessary to replace them with new ones

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

"Parrot Disease"

IN 1904, three cases of psittacosis or "parrot disease" were reported in Boston. Last fall an outbreak of this disease was reported in Buenos Aires and more outbreaks have recently been reported in the United States.

In Hamburg, Germany, 28 cases with five deaths occurred last fall. In the epidemic of psittacosis which occurred in Paris in 1892, there were 49 cases and 16 deaths and it was reported that the infection had been caused by parrots brought from South America.

The symptoms resemble those of other infectious diseases and one should be certain that the disease is actually psittacosis and not pneumonia or other infection of the lungs.

Obviously, the first step is to get the suspected parrot and to find out whether or not it contains the germs which are responsible. There is great doubt as to the exact organism that causes psittacosis. The most recent evidence seems to indicate that the germ is of the filtrable virus type. Experts are doubtful that the germs now commonly associated with the disease are the actual cause and they are more inclined to believe that it is probably a filtrable virus; that is to say, an organism that will pass through a mesh of clay filter and is too small to be seen in the ordinary microscope, but the presence of which can be determined by the fact that the disease can be produced on infection and by the reflection that it causes when specimens are looked at with the supra-ultra microscope.

The occurrence of such cases in the United States is new evidence of the fact that methods of transportation, exchange of products among various nations, and the complete abolition of boundary lines between peoples makes it impossible any longer for a nation to be isolated. The disease of one people will sooner or later appear among others.

Already cases of many of the tropical diseases have been found among the sick in the United States. It is probable that more and more cases are likely to appear in the future, notwithstanding the fact that the United States Public Health Service and all of the health organizations of various nations are concerning themselves with the prevention of such transmission.

Cancer

THROUGHOUT the world in hundreds of laboratories in research institutions efforts are being made to find the cause of cancer, to learn the nature of cancer, to aid in its early diagnosis, and to discover some specific cure. Recently, Dr. Charles F. Geschickter toured Europe and visited most of the cancer laboratories to find out what was being done in these various phases of cancer study.

It has been recognized for many years that workers with certain dyes, with tar and with pitch, were likely to develop cancer. Therefore, research workers use this method to produce cancers in mice and then study the cancer in the animal in a way that is not possible in the human being. Other workers were able to transplant cancer cells and have used this method in developing tumors in animals which are then studied by modern methods.

There are many workers who are convinced that cancer begins as a general systemic disease and that it represents in a way perhaps the natural end of man. However, this view has not been scientifically confirmed by experimentation.

Studies have been made of the chemistry of cancer, of the way in which the cancer cells use sugar as contrasted with the way normal tissues use sugar, and all of this has been of importance in learning about the nature of cancer, but has not led to immediate practical results.

It has been known for years that a cancer may arise from repeated irritation of certain cells in the body. Recent investigations tend to indicate that it is the cells of the body which are important in this connection, or the material that is used to bring about irritation, or perhaps even the irritation itself. Nevertheless, the irritation is a contributing factor, and for this reason repeated rubbing of dangerous spots should be avoided. This is particularly important as it relates to cancer in the mouth. Much can be done in prevention of cancer of the mouth by early attention to decaying teeth, rough edges, and similar sources of irritation.

Practically no serious worker in the field of cancer is willing to admit that there is an infectious origin or that the condition is in any way to be compared to infectious diseases. Many investigators are inclined to the view that no one cause, either inside or outside the body, is alone responsible for this disease, but that there may be several contributing factors. Cancer probably begins as a small lesion in one spot and then by a change in the nature of the tissue spreads throughout the body. Apparently the age of the patient has much to do with the manner of the spreading.

The search for a cancer cure is becoming widespread. Radium treatment has been receiving more and more attention, particularly as a means of treating cancers on the surface of the body. The lead treatment of which so much was heard five years ago is now practically discontinued throughout the world. Experiments are being conducted with it but it is not in any sense of the word a practically successful method.

Attempts have been made to suffocate tumors by putting around them an atmosphere deficient in oxygen. Other attempts have been made, notably by Sokoloff who made a small sensation with his method in the International Congress on Physiology, to eliminate the cancer by overbreathing. This work is of interest but in no sense of the word established.

Recently two investigators in the United States have noted interesting changes in cancer following the injection of extracts of glandular substances. The theory behind the use of this is complicated. Changes have been noticed in the tumors, but the evidence is not yet sufficient to warrant the belief that anything certain has been accomplished for the treatment of cancer by medical means.

Doctor Geschickter has established such criteria. He says: "A series of criteria for judging alleged cancer cures is easily formulated, although compliance with its requirements is difficult. We all know what we want or wish for any patient suffering from this disease. First, we want to face the facts and know for certain whether or not the patient actually has cancer. This implies biopsy. Secondly, we want to be able to cure cases in all stages, even in the face of recurrences and generalized metastases. Thirdly, we want the cure to be permanent. These three criteria, histologic diagnosis, cure of metastatic cases, and permanent cures established by follow-up examinations, extending over five year periods, should be applied to all alleged cancer cures.

"From this point of view immediate cures of local tumors in experimental animals, however intriguing, are false alarms. Serious and extensive clinical trial of any method by workers other than its advocate should await, first, the submission of the sections to substantiate the diagnosis in all cured cases; second, proof that the disease had progressed to dissemination at the time of treatment and, third, a five year follow-up to show the permanence of the cure."

Scarlet Fever

IN addition to treating scarlet fever by the use of specific antitoxin, it is possible to provide the sufferer with antitoxin through the blood of a person who has had the disease and who recovered. The health department in Detroit arranged to collect blood from people who had recently recovered and to keep it available for the use of those who might develop the disease. It was also used to protect people who had been exposed to scarlet fever against the disease.

The quarantine period for scarlet fever is 28 days. It was found that the convalescent serum protected people for short periods, but apparently the immunity created did not last longer than three or four weeks. The chief value of the method seems to be that it prevents outbreaks of scarlet fever in hospitals and in other institutions after one or two cases have developed. The method is also particularly suitable to use in young people who may react unfavorably to injection of the special fever antitoxin.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Spray Drying of Latex Revolutionizes Rubber Manufacture

ONE of the most interesting developments in the rubber industry in recent years was the development, by Ernest Hopkinson of the United States Rubber Company, of a revolutionary new process for the preparation of crude rubber from the sap of the rubber tree, which is known as latex. The process, as carried out at the plantations in Sumatra, is described by Hendrik de Leeuw, in a recent issue of *Chemical and Metallurgical Engineering.*

A latex spray-drying unit in a plant on the eastern coast of Sumatra

"The method for spray-drying rubber consists of atomizing latex by pouring it upon a disk installed at the top of a drying chamber, rotating at a high speed. Air heated to 350 degrees, Fahrenheit, intermingles with the particles of latex, drying them without raising the temperature to a point which would be detrimental to the rubber. The falling dried material resembles snowflakes. The mass of rubber is removed at intervals and pressed.

"A spray unit consists of a tank holding several hundred gallons, the spraying apparatus, and the drying chamber. Latex is forced through a rubber hose from the tank to the top of the cone, where it is led to the spray rotor which atomizes it, the fineness of the atomization being controlled by the speed of the rotation of the electrically driven 18-inch disk. The spraying apparatus is shaped like an inverted truncated cone. It reaches a diameter of 30 feet and is covered with steel plates. The heated air is produced by an oil-burning furnace located near the unit. The hot air is forced to the top of the cone through insulated pipe.

"The drying chamber or lower compartment is a concrete-walled room, 30 feet square and 30 feet high. At the bottom there is a series of parallel floors mounted on rollers. These floors can be withdrawn one at a time so that the dried rubber which has accumulated on them can be removed.

"Rubber as it comes from the drying room is in a spongy mass. It is pressed into a more compact mass by hydraulic presses, baled in heavy burlap and shipped to Belawan, the seaport of Deli."

Roast Beef In a Salt Shaker

THERE has recently appeared on the American market an Oriental condiment, Ajinomoto, advertised as imparting a meat-like flavor to soups, gravy, sauces, or vegetables. Inquiries that have reached this department reveal an apparently general assumption that this condiment is a concentrated meat extract. As a matter of fact, it is really an entirely synthetic flavor, the chemical name of its active principle being monosodium glutamate. [See also page 159, February, 1930 SCIENTIFIC AMERICAN. Editor.] In recent years, this product has become so popular that it is freely used like salt and sugar in the average Chinese home. The Chinese alone used 1,130,000 dollars worth of it in 1928. In the tropics people live principally on vegetable diet, and they resort to monosodium glutamate to improve the flavor of their simple food.

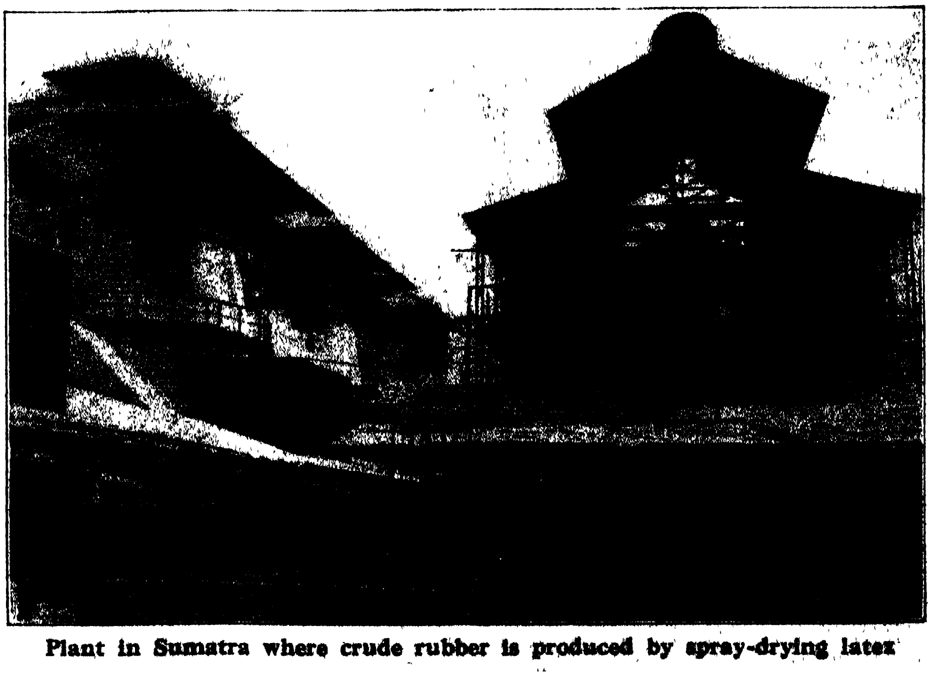
The Chinese process for the manufacturing monosodium glutamate is described by J. E. S. Han in a recent issue of *Industrial and Engineering Chemistry.* Gluten and concentrated hydrochloric acid are placed in a stoneware vessel provided with a reflux condenser, and heated over an oil bath at a moderate temperature until the protein in the gluten is dissolved. The temperature of the oil bath is then raised and the acid kept boiling until hydrolysis is complete. The product is filtered, the glutamic acid hydrochloride crystallized and purified, and finally neutralized with soda. The monosodium glutamate so obtained is crystallized, dried, and ground to a fine powder.

Coolies dusting and weighing the sponge rubber delivered from the drying chamber described in the text

How to Flame-Proof Fabric

A REPORT published in the British Fire Prevention Committee Red Books, outlines the method generally known as "non-flame" process which gives a good fire-retardant effect and has the further merit that this effect remains after the material has been subjected to washing or the weather. In tests made by the British Fire Prevention Committee, flannelettes were found to have been little changed after 20 washings. The process consists in steeping the cloth in a solution of three pounds of sodium stannate per gallon of water used (specific gravity 1.07). After wringing and drying it is rinsed several times in running water and finally dried.

A less permanent treatment can be made by subjecting the cloth to a solution consisting of two pounds of ammonium sulfate



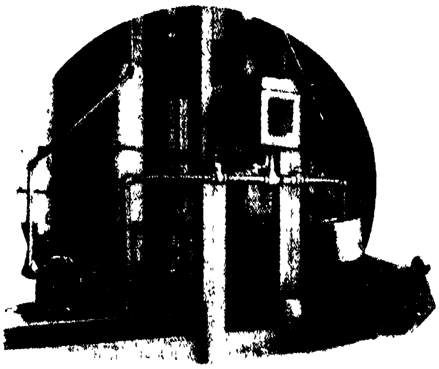
Plant in Sumatra where crude rubber is produced by spray-drying latex and four pounds of ammonium chloride (sal ammoniac) in three gallons of water.

Sodium silicate is fairly effective for interior decorations where change of color or luster is not important. For this purpose one volume of commercial water glass (1.39 specific gravity) is diluted with one to five volumes of water, depending upon the kind of fabric and the degree of fire-retardant effect desired.

Where Does the Bootlegger Get His Alcohol?

"RECENT indictment of corn sugar manufacturers, yeast companies, and industrial establishments engaged in various branches of the chemical industry has attracted attention to a new phase of alcohol control," points out I. D. Foos in a recent article in *Chemical and Metallurgical Engineering*. "There have been three cycles in prohibition enforcement. In its first stage, the authorities concentrated their energies on preventing the diversion of existing stocks of whisky. Next, they turned their attention to checking widespread diversion of industrial alcohol. Now they are attempting to block the movement of otherwise legitimate products to illicit distilleries and hence have brought yeast, corn sugar, and other industrial materials into the prohibition limelight.

"Through it all, the manufacture of 'moonshine,' defended by the southern highlander as a birthright, has persisted. But as the diverted supply of industrial alcohol has diminished, moonshining has assumed the characteristics and proportions of an industry. The moonshiner's kettle in the swamps and mountains has been supplemented by column stills, operated on a factory scale, located in or close to all the larger cities, particularly in the north. Here corn sugar mash is used in preference to cane and beet sugar, cornmeal, or molasses, because of its rapid fermentation. Usually, it is necessary only to add yeast to this, as the protein content of this type of sugar provides sufficient yeast food so that when accelerated by heat, a ripe mash is produced within 24 hours. Ordinarily, such corn sugar also enjoys a price differential of approximately $1.50 per hundred-weight; this, of course, is an advantage, even though cost is not a primary factor in this business.



When the "big-time" bootlegger sets up a plant in the city, his equipment usually includes vertical stills like the one illustrated above

"Estimated at one billon pounds last year, the production of corn sugar has increased sevenfold since 1921.

"The increase in production of this material from approximately 152,000,000 pounds in 1921 to 538,000,000 pounds two years later may not have had any prohibition significance, but the federal authorities certainly believe that the rapid increase which took place after 1926 was of serious import. They point out that this increase of corn-sugar manufacture occurred simultaneously with the voluntary curtailment of industrial alcohol. Furthermore, it is certain that not only this curtailment but also the improvement of denaturing formulas, did much to make more difficult and expensive the reclaiming for beverage purposes of alcohol from either partly denatured or fully denatured forms. In any event, seizures of stills conclusively prove that the art of bootlegging has taken on many of the improvements which have been currently effective in other industries which also demand chemical-engineering skill and equipment."

Two Gases Make Fertilizer

RECOVERY of ammonia as sulfate in gasworks and elsewhere is now confronted by so many economic difficulties that any process which promises to lower costs deserves serious consideration, says *Chemical Age*. A German chemist, Dr.

(*Please turn to page* 407)

Large-scale production of illegal alcohol requires the installation of huge mash tanks such as the ones shown

Not efficient from the chemist's point of view, but picturesque, is this typical still found in the southern hills

This "moonshine" still in southern Maryland had an output of 1000 gallons per day

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

Agriculture

Fresh and Canned Fruit Industry of Porto Rico. (Trade Information Bulletin Number 669. Department of Commerce). A general survey of the Porto Rican fruit industry. *Superintendent of Documents, Washington, D. C.—10 cents, (coin).*

Forest Plantations at Biltmore, N. C., by Ferdinand W. Haasis. (Miscellaneous Publication Number 61, United States Department of Agriculture). Describes one of the earliest large-scale reforestation projects. Fully illustrated. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

Indian Corn, by James B. McNair. (Leaflet, Botany Number 14, Field Museum of Natural History). Pamphlet deals with the origin, geographic distribution and varieties of Indian corn, its uses by the American Indian, and the modern industrial and experimental products. *Field Museum of Natural History, Chicago, Ill.—25 cents.*

The Corn Borer in Central Europe, by K. W. Babcock and A. M. Vance (Technical Bulletin Number 135, Department of Agriculture), is a report of a four-year research program carried on in central Europe in an effort to obtain information which might help to check the spread of the corn borer in the United States. *U. S Government Printing Office, Washington, D. C.—20 cents (coin).*

Selective Logging in the Northern Hardwoods of the Lake States, by Raphael Zon and R. D. Garver (Technical Bulletin Number 164, United States Department of Agriculture). Selective logging is fundamental to industry of forestry in the hardwood forests. The pamphlet gives a wealth of information. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Investigations in Weed Control by Zinc Sulfate and other Chemicals at the Sarenac Forest Nursery, by W. G. Wahlenberg. (Technical Bulletin, Number 156, United States Department of Agriculture.) Pamphlet shows how the weed problem was solved at a tree nursery. It represents ten years of investigation. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

Metals

The Relation of Carbon Residue to Lubricating Performance. This issue of *Lubrication* gives valuable information on the subject. *The Texas Company, 17 Battery Place, New York.—Gratis.*

Significant Developments Regarding Soil Corrosion, by Henry W. Hough. This reprint gives the important developments in soil corrosion research, the significant trends, and their effects is ameliorating the ever present corrosion problem. *Henry W. Hough, 46 Carnegie Ave., East Orange, New Jersey.—Gratis.*

Commercial Chromium Plating, by Richard Schneidwind (Circular Series Number 3). This pamphlet of 60 pages deals with general information necessary for the design of chromium plating equipment, and discusses the defects of chromium plating. *Department of Engineering Research, University of Michigan, Ann Arbor, Mich.—50 cents.*

Periodicals

Cellulose. A new trade paper devoted to cellulose, its derivatives and products. *The Cellulose Publishing Co., 114 East 32nd Street, New York City.—$3.50 a year, 35 cents a copy.*

Machine Design. A new trade paper devoted to machine design as it affects engineering, production, and sales. It is now in its second volume. *The Johnson Publishing Co., Penton Building, Cleveland, Ohio.—$3.00 a year.*

Sporting Goods Journal Catalog 1930, edited by H. C. Tilton. A combined catalogue of sporting goods manufacturers and cyclopedia of sports. A valuable treatise on sports. Supplied gratis to subscribers to the *Sporting Goods Journal, 521 Fifth Ave., New York City.—$2.00 a year.*

Air Travel Guide—A ready reference handbook published and revised on the first of each month and containing latest authoritative information for those who travel, mail, or ship by air. Full timetables and rates given. Excellent air passenger maps. *Air Travel Guide, Ltd., 565 Market St., San Francisco, Cal.—35 cents.*

Science

Motion Pictures and Illustrated Lectures. Illustrated catalogue of motion pictures, technical and non-technical, and films with synchronized sound, made and distributed by the General Electric Co. These films are of great educational value. *General Electric Co., Schenectady, N. Y.—Gratis.*

Ethnology of Africa by Wilfred D. Hambly, Assistant Curator of Ethnology at Field Museum. Systematically sets the puzzled reader straight about the many African races—negro, Bushman, Bantu and especially the mixed white-black races of northern Africa. Virtually a text book. 222 pages, 42 plates. *Field Museum of Natural History, Chicago.—$1.59.*

Roosevelt Wild Life Bulletin and Roosevelt Wild Life Annals. Two serial publications of interest to nature lovers, containing illustrated studies of bird life, fishes, trees, and so on. Each number is in the nature of a monograph. *Roosevelt Wild Life Forest Experiment Station, Syracuse, N. Y.—Bulletin $1.00 an issue and Annals $1.25.*

How to Make an Insect Collection, How to Make Skeletons, Notes on Marine Aquaria, and Insect-Eating Plants are a few representative titles from the Turtox Service Leaflets. Turtox News, a monthly bulletin issued by the same firm, is sent to approximately 20,000 biology teachers in the United States and foreign countries. *General Biological Supply House, 761 East 69th Street, Chicago—Gratis.*

Brief History of Polar Exploration since the Introduction of Flying, by W. L. Joerg. American Geographical Society's 50-page history of all arctic and antarctic expeditions using aviation. Colored maps (23 by 18) of arctic with all relevant data, and bathrymetric map (14 by 26) of southern seas and Antarctica. Both maps worthy of this society of professional geographers. *American Geographical Society, Broadway at 156th St., New York City.—$5.00.*

Miscellaneous

Birthstones. A beautiful little brochure, in which the gems are shown in color in the matrix, as cut, and as presented in jewelry. There is a "birthstone" map. Printed in full color. *Cartier, Fifth Ave. and 52nd St., New York City.—Gratis.*

Taking the Risk Out of Hides deals with the hide futures market, explaining how it is used by packers, tanners, importers, exporters, dealers, and manufacturers. Other publications of a similar nature deal with such commodities as grain, sugar, rubber, cotton, and raw silk. *Harris and Vose, 60 Beaver Street, New York—Gratis.*

Water Pollution Research, Summary of Current Literature (Abstracts 1 to 119), contains summaries under six main headings as follows: Water Supplies, Analysis and Examination of Water, Sewage, Trade Waste Waters, Pollution of Natural Waters, and Miscellaneous. *Department of Scientific and Industrial research, 16 Old Queen Street, Westminster, S. W. 1, England—85 cents (money order).*

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MAKE	MODELS	Front Wheels	Rear Wheels	Pinion	Steering	Differential
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Cadillac	All				x	x
Chrysler	66, 70, 77	x	x	x		x
	Imperial	x				x
Cord	All	x	x		x	x
Cunningham	All	x	x	x		x
DeSoto	All	x	x	x		x
Dodge	All	x	x	x		x
Durant	614	x	x	x	x	x
	617	x	x	x		x
Elcar	75	x	x	x		x
	95, 96, 120	x	x			x
Erskine	All	x	x	x	x	x
Essex	All	x	x	x		x
Ford	All	x		x	x	x
Franklin	All	x	x	x	x	x
Gardner	All	x	x	x		x
Graham	Standard Six	x	x	x	x	x
	Special Six	x	x			x
	Eights	x	x		x	x
Henney	All	x	x	x		x
Hudson	All	x	x	x		x
Hupmobile	S & C	x	x	x	x	x
	H & U	x	x	x		x
Jordan	All	x	x	x		x
Kissel	73 & 95	x	x	x		x
	126	x	x	x	x	x
Kleiber	All	x	x	x		x
LaSalle	All					x
Lincoln	All	x	x	x	x	x
Locomobile	86 & 88	x	x			x
Marmon	69	x				x
	79 & 11	x	x			x
McFarlan	All	x	x	x		x
Moon	All	x	x	x		x
Nash	Std. 6	x	x	x	x	x
[redacted]	All	x	x		x	x
Peerless	B & C	x	x			x
	A	x				x
Pierce-Arrow	All	x	x	x	x	x
Plymouth	All	x	x	x		x
Reo Flying Cloud	20 & 25	x	x		x	x
	15	x	x			x
Roamer	All	x	x	x		x
Roosevelt	All	x	x	x		x
Studebaker	All	x	x	x	x	x
Stutz	All	x	x	x		x
Whippet	All	x	x	x	x	x
Willys-Knight	All	x	x	x	x	x

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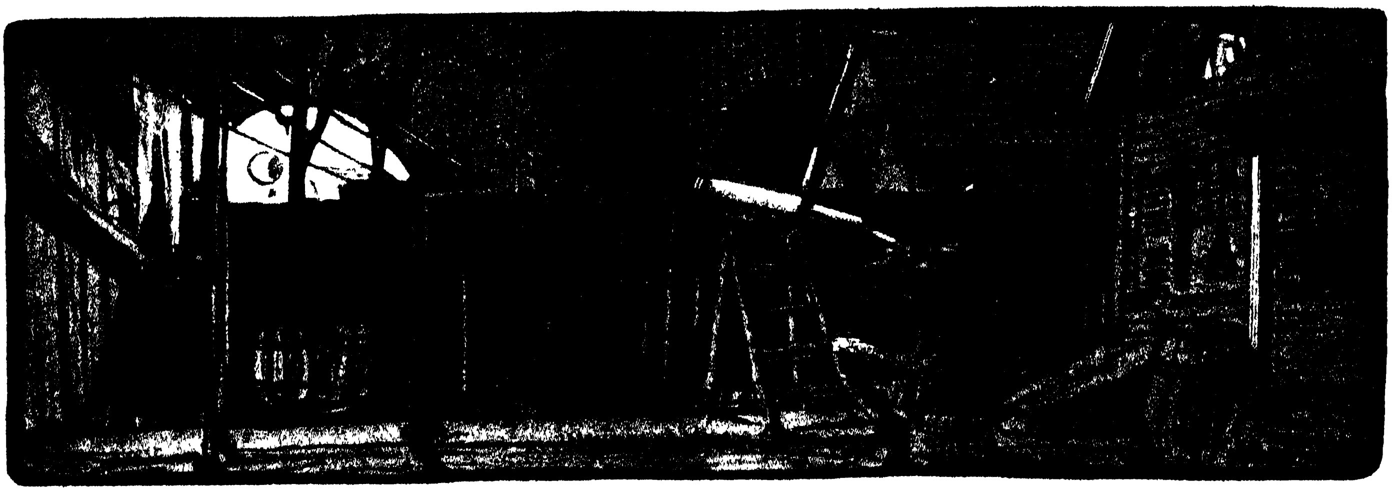
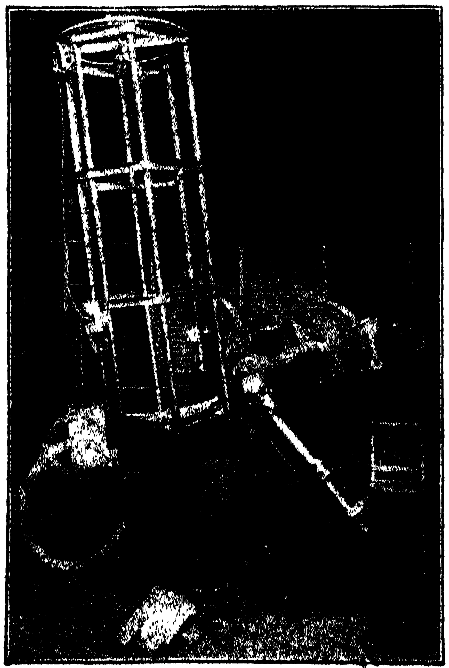


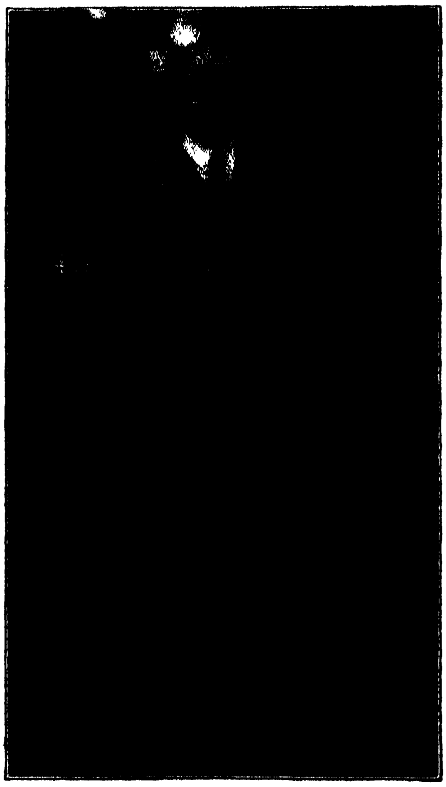
The Amateur Astronomer

AMATEUR telescope makers who recall the publication of the Reverend W. F. A. Ellison's picture in the March number, and the suggestion there made that it be clipped out and pasted in the instruction book, "Amateur Telescope Making," may wish to do as much with the photograph which appears at the right. This picture of Mr. Porter, which was taken by Dr. Clyde Fisher, president of the *Amateur Astronomer's Association,* (American Museum of Natural History, New York), is a much better likeness than the one on page 19 of "Amateur Telescope Making." Mr. Porter is still at Pasadena co-operating on various pieces of work, optical, mechanical, and architectural, preliminary to the final construction of the 200-inch reflecting telescope.

THIS month we shall discuss the merits of the open or skeleton tube reflector, in contradistinction to the more common closed or solid-sided tube, and two open-tube telescopes of this type are shown here. Of these the one below is a strictly professional job. The mirror was made some years ago by Ritchey, who also supervised the construction of the mounting. The figure of the mirror is very perfect, and extremely fine photographs of nebulae have been obtained with it, according to Director E. B. Frost of Yerkes Observatory, mainly by Ritchey, when the latter was connected with this Williams Bay, Wisconsin, institution. A detailed description of this reflector will be found in Volume 14 of the *Astrophysical Journal,* and a large photograph for those who care to study its structural detail may be had from the Observatory, for 50 cents.



24-inch at Yerkes



Russell W. Porter

The other skeleton tube telescope is one recently built by Professor Dinsmore Alter of the University of Kansas and Mr. William Pitt, retired manufacturer. As several requests for information have failed to bring forth much satisfaction (the photograph itself having been purchased from a news photograph agency), no details can be stated here, except that it has been known among astronomers for several years that Professor Alter was engaged in making the instrument. The 27-inch mirror was made from a 27-inch disk of Pyrex four inches thick.

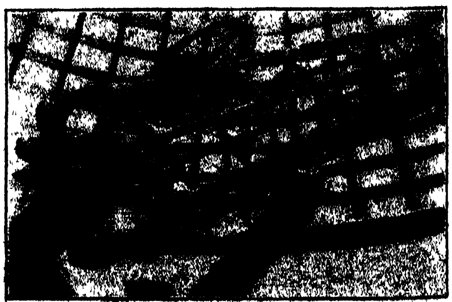
OPEN-TUBE telescopes of the kind just mentioned are strongly advocated by the Reverend T. E. R. Phillips, M.A., F.R.A.S., and F. J. Hargreaves, F.R.A.S., in comment reproduced by kind permission from the *Journal of the British Astronomical Association* (London). The Reverend Phillips is Director of the Section on Jupiter, and Mr. Hargreaves of the Section on Photography, of that organization. They write:

"There is a widely held view that reflectors are much inferior to refractors in defining power, assuming equal optical quality, and there can be little doubt that in most cases this is so, especially when the reflector tube is of metal and closed on all sides. Experience over a long period at Headley with an 8-inch refractor and a 12¼-inch reflector in an iron tube shows that the number of nights when the image in the reflector is as good as that in the refractor is very small.

"A third instrument at Headley, the Association's 18-inch reflector, formerly the property of the late N. E. Green, has recently been remounted in the dome formerly occupied by the 12¼-inch, and its performance since remounting is worthy of record insofar as it affects the question of the relative merits of the two types of instrument.

"Before the remounting, the 18-inch mirror was carried by a square wooden tube, completely closed on all sides, and the image usually had the well-known reflector characteristics—unsteadiness, lack

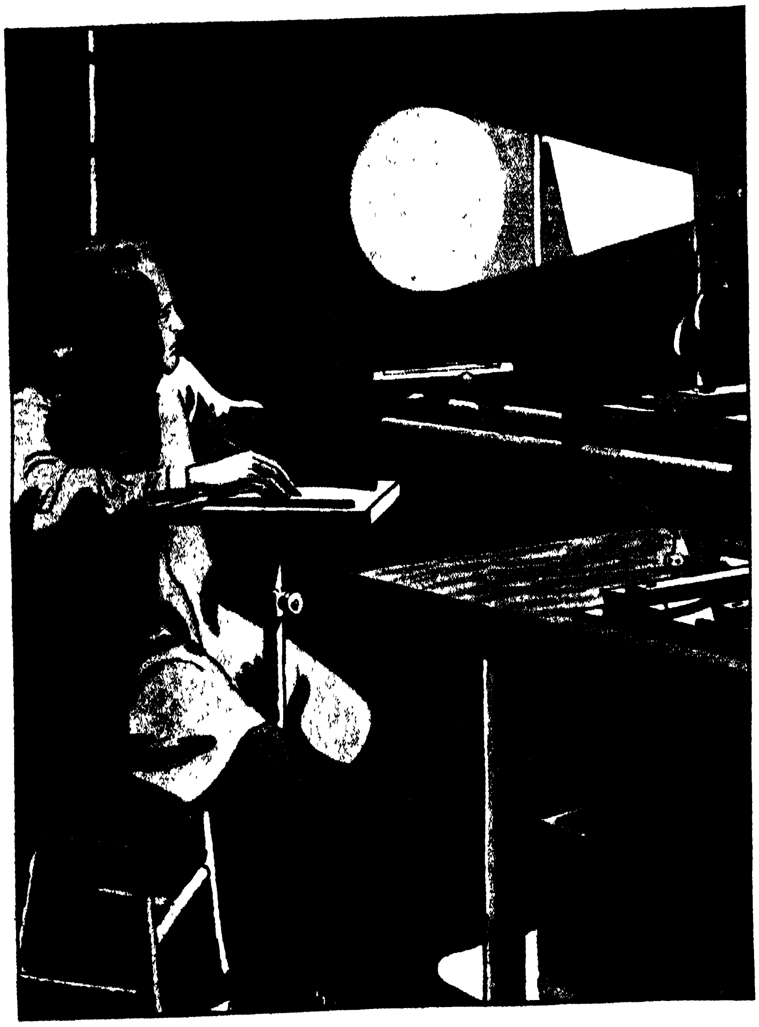
(*Please turn to page* 405)



[illegible]lter-Pitt reflector

A RAINBOW

now helps to make Better Machines



Up the hill to the busy Westinghouse research laboratories in East Pittsburgh come engineers of a great industry asking, "What shape shall we make these machine parts to get the greatest strength from our materials?"

Light flashes on a snow-white screen. Outlines on the machine part appear. Then someone turns a loading screw and areas of color are seen changing their hues as the load on the test model increases. Black turns to gray, gray to yellow, yellow to red, brown, green and so on. In this manner the machine part appears in colors of a laboratory rainbow that tells its own story for keen eyes to read—a well-directed ray of light discloses where the heaviest stresses are.

"Photo-elastic tests" the engineers call them. And from tests like these slight changes in shape give vast gains in strength without added material. Sometimes even less material actually gives greater strength. A laboratory rainbow does what the most elaborate calculations could not do.

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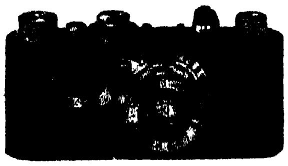

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Our Point of View

France and the Naval Conference

(Continued from page 349)

building program; and, thanks to their large additions to the cruiser strength made since 1921, they are in an excellent position to resume competitive building.

The economic position of France is better than at any time since the World War. There is no unemployment problem, her gold reserve is large, the reconquest of Alsace and Lorraine makes her self-sufficing for coal and iron, and as long as she controls the Mediterranean route to Algiers, her supply of foodstuffs is secure. So France faces the future with confidence, is encircling her land frontiers with modern fortifications, and purposes to provide sufficient naval force to secure her position in the Mediterranean. Tardieu's demand on Stimson and MacDonald for guarantees in exchange for naval limitation is suggestive of Clemenceau's demand on Wilson and Lloyd George for a security pact in exchange for the League of Nations. France pursues a consistent course in her foreign policy.

Italy stolidly reiterates her claim to absolute parity with France. England claims she must maintain a navy equal to the combined navies of the next highest European navies; and her agreement to reduce her tonnage to an amount acceptable to us is contingent on her tonnage being equal to the combined tonnage of France and Italy.

Britain is willing to give the guarantees required by France if we will countersign the guarantee, but our delegation well knows that though the American public is anxious for naval limitation, it will not purchase limitation by again involving the country in Europe's affairs. When the British delegation is asked to find a formula acceptable to France they point to their existing obligations under the Locarno and the Lausanne agreements to use their fleet to support the decisions of the League of Nations against an aggressor nation, pointedly remind us that we have not accepted any such obligation, and request us to share any further responsibilities Great Britain is called upon to assume. This part of the problem therefore is developing just as anticipated.

Great Britain and the United States could agree on a parity at a tonnage not in excess of that which the United States is willing to build, if France and Italy combined would not build a larger fleet than Britain's. If France insists on 700,000 tons, and Italy insists on as much, then Great Britain must have 1,400,000, which is more than the United States wants to build. Great Britain, on the other hand, is willing to build the larger tonnage and expresses a perfect willingness for us to achieve parity by building up to her requirements.

There is a small but influential section in Great Britain that rather welcomes the threatened impasse on the theory that the United States is unwilling to spend the money on its fleet necessary to achieve parity, and that Great Britain, having made its gesture of accepting parity with the United States, will, if the Conference fails, be free to continue its building program and once again achieve an overwhelming sea supremacy. For our part we believe that the American people are resolved to have a navy second to none and while they would prefer to spend their revenues on internal improvements, they are prepared to maintain their fleet if the complexities of European jealousies make this necessary. Ours are a busy people, more intent on their daily tasks than on world politics. They are a peaceful people, enjoying more prosperity than others and consequently unenvious of others, but they are fully aware that their prosperity is dependent on their sea-borne commerce, inter-coastal as well as foreign. In the World War, they saw the sea-borne commerce of Germany, who possessed the second best navy in the world, swept off the seas within 30 days and we are confident that never again will the United States be content with a navy that is not equal in every class of vessels to that of any other nation.

Japan and the United States are discussing the ratio of cruisers, destroyers, and submarines; Japan demands 70 percent but the United States claims that Japan is morally committed to a 60 percent ratio, the same as in capital ships. Japan has the legal right on her side, but unquestionably it was the understanding of this country when it agreed to restrict the fortifications of its Far East posses-

(Continued on page 407)

SHIP-BUILDING PROGRAM, 1921-1929—CRUISERS.

UNITED STATES			GREAT BRITAIN			JAPAN		
No.	Tonnage	Cal. Guns	No	Tonnage	Cal. Guns	No	Tonnage	Cal. Guns
10	7,000	6"	7	5 to 8,000	6"	13	5,200	5.5"
1	10,000	8"	13	10,000	7.5" or 8"	8	7 to 10,000	8"
11	80,000	6" to 8"	20	169,000	6" to 8"	21	136,000	5.5" to 8"
DESTROYERS								
None			30	38,400	4.7"	61	73,700	4.7"
SUBMARINES								
38	800	4"	8	800 to 1,000	4"	36	800 to 1,000	4.7"
4	2 to 3,000	5" to 6"	11	1,500 to 2,500	4" to 5"	19	1,400 to 2,000	4.7"
42	39,400		19	24,200		55	66,000	

The Scientific American Digest

(Continued from page 394)

on a wet soil is prevented. Water will sink through that kind of a furrow several times faster than from a shallow furrow.

The advantages of the deep-tillage system (with sub-soiling and without plowing) and cover crop culture have been summarized by the Agricultural Extension Division, University of California, as follows:

(1) The cost, as compared to plowing and ordinary tillage methods is reduced in some cases as much as 50 percent. (2) All cultural operations are speeded up, making it possible to take advantage of favorable weather conditions. (3) Incorporation of the organic matter (cover-crop) throughout the entire area of the soil, is facilitated. (4) The humus content of the soil is increased. (5) The soil is given greater water-holding capacity. (6) The soil (especially in orchards) is more easily kept level. This is important in irrigated districts. (7) By conservation of moisture, the number of necessary irrigations is lessened. (8) More complete aeration of the soil results, with consequent increase in the beneficial activity of soil bacteria and fungi. (9) Roots (of fruit trees) are pruned, with the result that fine feeder roots are put out, increasing the assimilation of moisture and plant food. (10) The friability and general physical condition of the soil are improved.

Strange Stone Head Discovered in Texas

A GREAT stone, naturally shaped like a human head and carved with teeth, ears, eyes, and flattened chin, is a strange new discovery from Texas, unearthed from its resting place beneath 16 feet of undisturbed gravel.

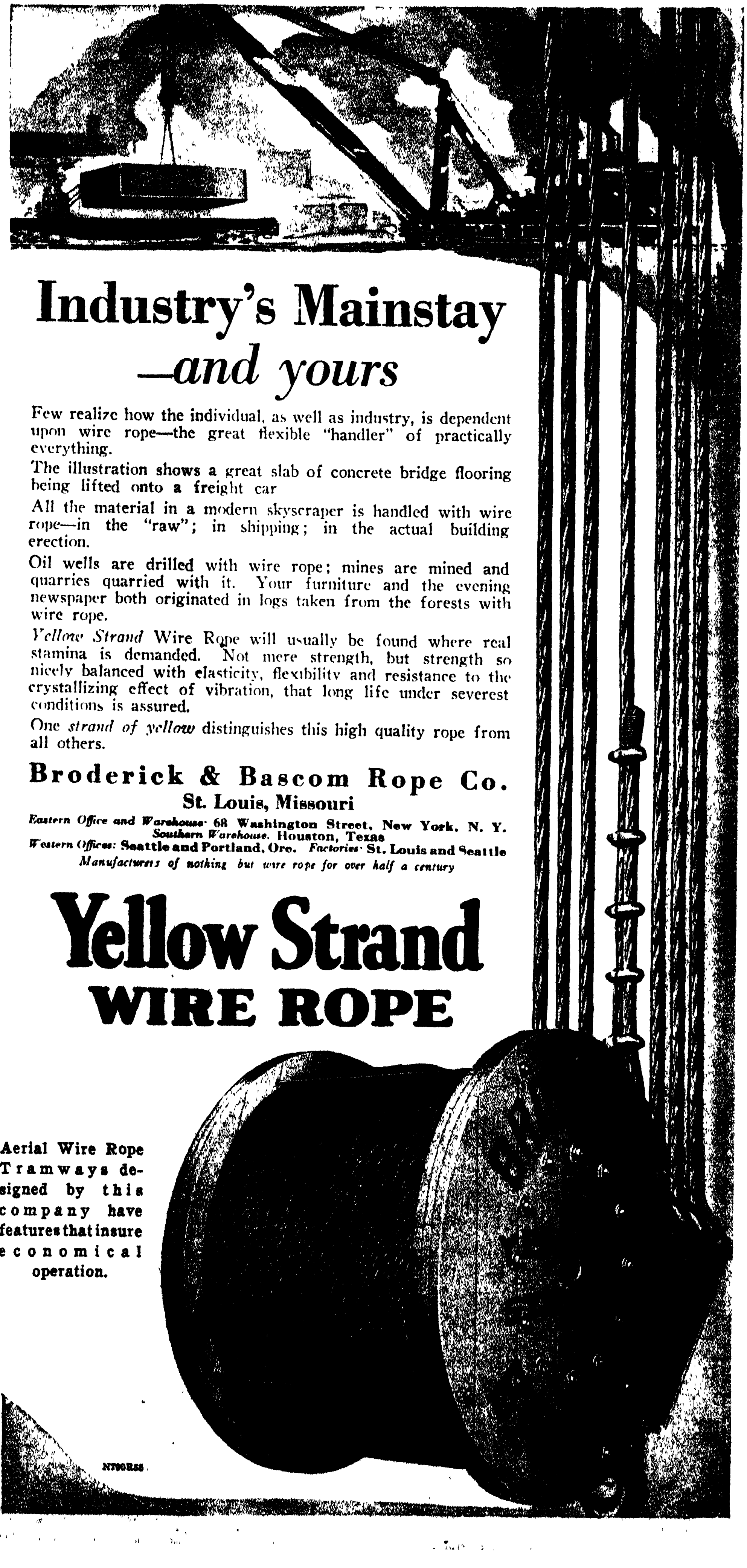
Dr. E. H. Sellards, geologist of the University of Texas, brought news of the discovery to the Paleontological Society. The stone head appears to be a new piece of evidence that man existed in America in ancient times.

Judging by the geological conditions of the region, the stone must have lain in place while the gravel from nearby streams washed over it forming finally a layer more than 16 feet deep, Dr. Sellards said. The streams have long since ceased to wash gravel over the site. The stone weighs at least 75 pounds, possibly 100, he reported. —*Science Service.*

Ford Adopts New Alloy

WHEN the redesigned Model A Ford was announced late last December, the official description stated that exterior metal parts were made of rustless steel. It is now learned that the metal referred to is not the usual rustless steel, but an entirely new alloy never before used in automobiles. The Ford company's adoption of the product has more than doubled its output in this country.

The new alloy is known as Allegheny metal. The original formula for its manufacture was developed in Germany during the war, when armament plants were seeking the hardest possible substance suitable for gun lining. At about the same time, the English also worked out the formula. It was not until after the war, however,



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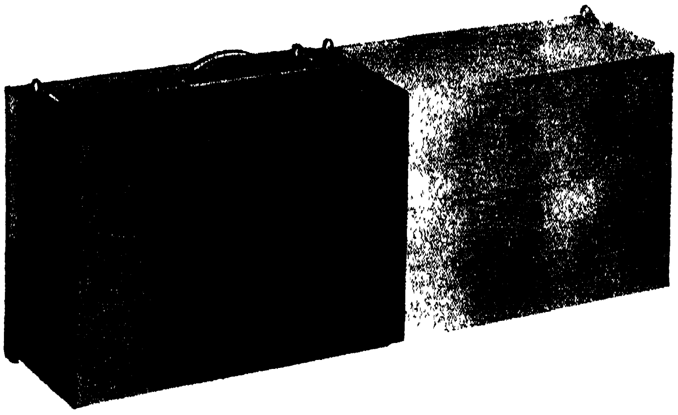

Here is an opportunity to acquire the manufacturing rights to an invention relating to collapsible cases which telescope lengthwise. The telescoping parts lock solid when the case is closed, the lid may be opened in any position, and a movable handle establishes balance for carrying. These principles can be applied to any type of carrier from a personal hand bag to a trunk. Any material could be used for construction, wood, canvas, leather, cane, fiber, composition, papier mache, metal, etc. One of the most popular and useful applications of this invention would be to bags such as the one illustrated.

The possibilities of this telescoping principle as applied to industrial shipping cases should not be overlooked. Such a case made of unbreakable waterproof papier mache would institute a tremendous saving in shipping certain types of products since they could be used repeatedly and are adaptable to the size of the shipment.

Manufacturers interested in this device should write the inventor,

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that the commercial production of the alloy was contemplated and it was only a few years ago that methods for its economical manufacture in large tonnage were developed.

The Ford requirements are said to be about 1000 tons a month. This represents two thirds of the entire output of the American factories and one third of the output of the world, which is now about 3000 tons. When he adopted the alloy, Mr. Ford had to scrap several million dollars' worth of equipment originally installed for fabricating and polishing the nickel used in the original Model A.

Allegheny metal is said to be nonrusting, untarnishable, non-corrosive, and not affected by weather in any way. It is also one of the hardest metals known to the steel industry. It is an alloy of refined steel combined with about 18 percent of chromium, 8 percent of nickel and smaller proportions of carbon, manganese, silicon, phosphorus, and sulfur. It is the complicated method of combining these elements that gives the alloy its properties, it is explained.

Before its adoption by the Ford Company, production of the alloy was limited, because it was used only for building trim, cooking utensils, dairy equipment, and other articles for which it met special requirements. It is now being considered for use in the bars of State penitentiaries, according to report, because it is so hard that it cannot be sawed or otherwise cut by any hand tool.—*The New York Times*

Measure Wind Passing Through Brick Walls

WIND blows right through brick walls. A well-laid 13-inch wall in the face of a 30-mile-an-hour wind will allow 14.75 cubic feet of air to pass through it every hour, G. L. Larson, D. W. Nelson, and C. Braatz reported to the International Heating and Ventilating Exposition in Philadelphia recently. This data is obtained from researches they have conducted at the University of Wisconsin.

But proper plastering with gypsum directly on brick, they find, will stop 96 percent of the leakage. Less air will leak through a wall which has been well constructed and in which all spaces between bricks are filled with mortar.—*Science Service*

Test Shows Efficacy of Auto Oil Filter

IF automobiles are equipped with oil filters, frequent changes of oil in crankcases are unnecessary, a test trip across the continent by A. H. Hoffman, associate agricultural engineer at the University of California agricultural experiment station, tends to show.

On the trip, during which the speedometer showed 10,025 miles of travel, Mr. Hoffman found that after a change of oil, the viscosity dropped rapidly for about 200 miles, and then changed little for 5000 miles.

The tests on acidity were much the same, the acidity rapidly rising for about 200 or 300 miles, then showing small variation.

Only one machine was used in the experiment. In addition to the oil filter it had a crankcase ventilator, and both carburetor and breather were protected against dust. The test was made in warm weather.—*Science Service.*

The Amateur Astronomer

(*Continued from page* 400)

of crispness, and inability to bear high magnification.

"The sides of this wooden tube were made after the manner of a door, with stiles, rails, and panels. The panels having for the most part rotted, they were removed prior to the re-mounting of the instrument, and it was decided not to close in at once the large openings left by their removal, in order to observe the effect of allowing the air to circulate freely through the tube. In brief, the effect is to remove completely the characteristic defects of the reflector, so far as planetary images are concerned.

"The performance of this instrument has surpassed all expectations—so much so that in spite of the great disparity of aperture it is now rare to find, on occasions of poor seeing, that the refractor image is steadier or better-defined than that of the reflector.

"It should be understood that no claim is made for novelty in the idea of the skeleton tube, which, of course, is used for all the very large reflectors; it is only desired to point out the very great benefits to be obtained by adopting this type of tube for the smaller instruments, for which it has not hitherto been generally used.

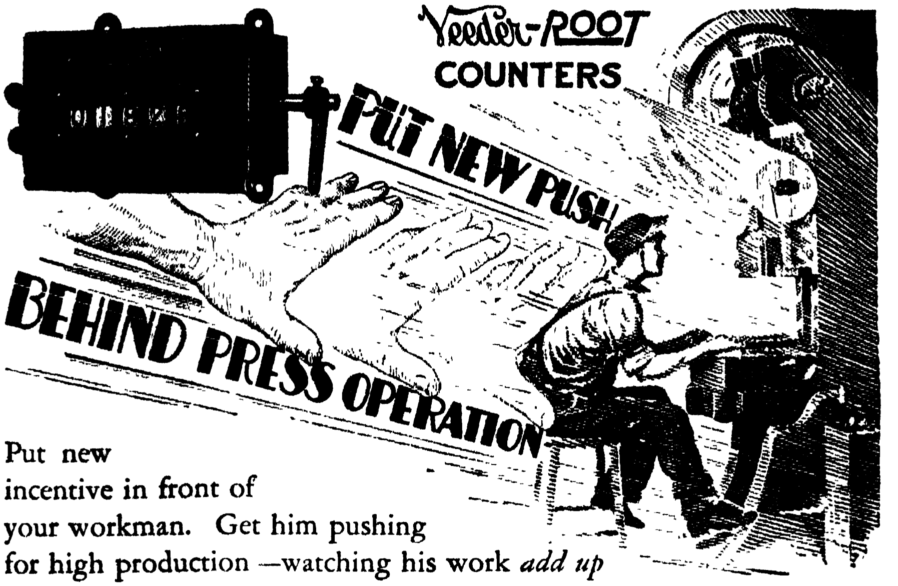
"Experiments have shown that when the external temperature is falling, as of course is the general rule at night, it is impossible to keep the temperature of the air inside a "closed" tube uniform and equal to that of the external air. An electric blower sending a current of air up the tube is a help in the smaller sizes, but the trouble begins again as soon as the blower is stopped. In the case of a metal tube, the upper wall becomes colder than the lower wall by radiation, thus setting up convection currents within the tube. If the tube is lagged with felt, or if it is of wood, this trouble is avoided in part, but the tube and the air within it will then remain warmer than the external air during the whole time that the temperature is falling, and for some time after.

"The presence of this mass of relatively warm air can be made visible readily when the conditions are suitable. The telescope should be directed to a bright star and the eye-piece racked out considerably to give a large out-of-focus disk, which will be seen to be irregularly in motion. If an assistant then opens the door near the bottom of the tube and flaps a piece of cardboard vigorously in front of the opening, the out-of-focus disk will "boil," owing to the inrush of the cooler air. The air within the tube can be readily set in rotation by this means, and the rotation is visible in the eyepiece; but no amount of flapping will bring about uniform conditions."

So much for one side of the question. In a long article entitled "Reflectors versus Refractors," in the March number of *Popular Astronomy* (Northfield, Minn.) Prof. W. H. Pickering discusses both sides.

●

STILL another telescope, a 19-inch reflector having an open tube, is described in the January, 1980, number of the *Journal of the Royal Astronomical Society of Canada*, by its maker, Professor R. K. Young, of the Department of Astronomy at the University of Toronto. The illustrated article is detailed (16 pages) and ought to be obtained by every amateur who aspires to



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make a fairly large telescope at some future date. The address is *Journal of the R. A. S. C.*, Mr. H. W. Baker, Treasurer, 198 College Street, Toronto, and the price is 25 cents.

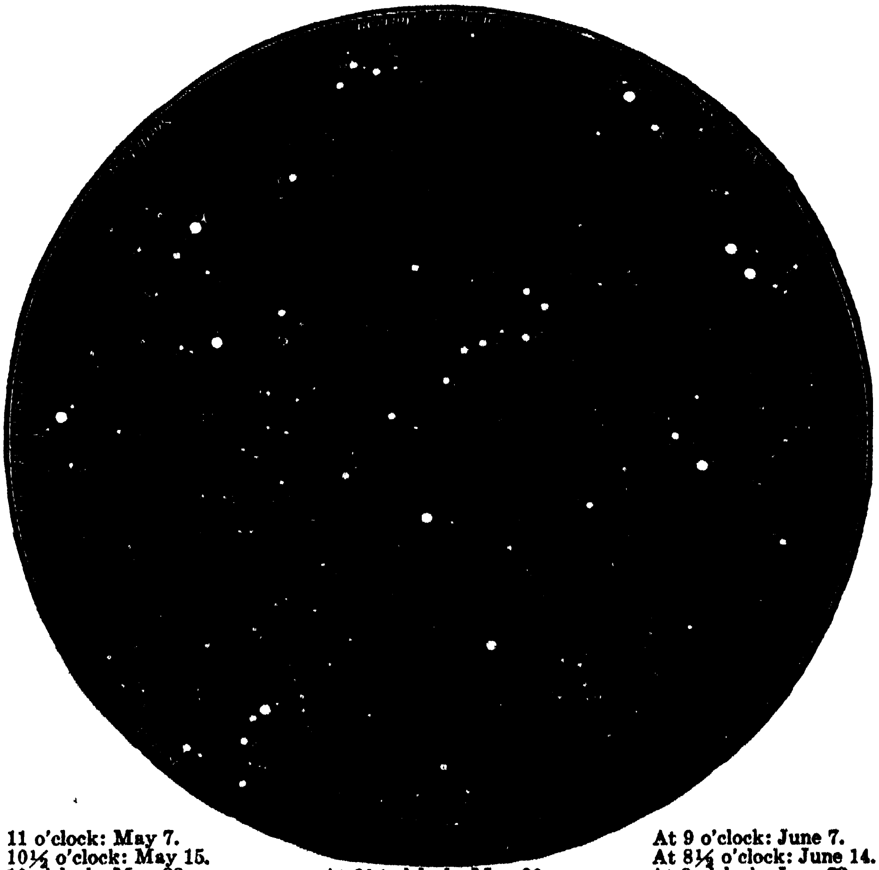
Another current scientific journal which those who are especially interested in the Hale spectroheliscope should not miss is the December, 1929, number of the *Astrophysical Journal* (5750 Ellis Avenue, Chicago; 75 cents), containing a 46-page article on that instrument written by Dr. Hale and strikingly illustrated by R. W. Porter. Since the publication of "Amateur Telescope Making" with its description of the spectrohelioscope, numerous alterations in design have been made.

Professor Charles W. Woodworth of the University of California, is making a mosaic type of telescope containing 400 mirrors, each 15 inches in diameter, and all attached to a single rigid backing. Each is to be adjusted, if possible, to the position called for by theory. Dr. Woodworth submitted his idea to this journal a year or more ago and the opinion given through one of its corresponding editors was that the theory was correct but in practice the difficulties would probably prove insuperable (see "A. T. M.", page 242, near bottom). He is now trying it out, and this is the correct procedure in cases where there is any doubt. Dr. Woodworth is an entomologist who has specialized on microscope theory, with which telescope theory has much in common. The amateur fraternity will wish him success.

—*A. G. I., Tel. Ed.*

The Heavens in May

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.
At 9½ o'clock: May 30.
At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on May 7, etc.

NIGHT SKY: MAY AND JUNE

Mercury is an evening star till the 20th and then a morning star, but can be well seen only during the first few days of the month. Venus is an evening star, growing more and more conspicuous as she comes north and gets farther from the sun. She sets at 8:30 when the month begins and 9:30 at its close. Mars rises in the neighborhood of 3 A.M. but is still almost 200,000,000 miles away and in consequence looks but little brighter than a star of the second magnitude. Jupiter is still an evening star but is getting low in the west. By the end of the month he sets a little after 8 P.M. and can hardly be seen. Saturn is in Sagittarius and rises at 10:30 P.M. in the middle of the month. Uranus is a morning star rising at 3 A.M. in the middle of the month, while Neptune is in quadrature on the 22nd and becomes an evening star.

The moon is in her first quarter at noon on the 5th; full at noon on the 12th; in her last quarter at 11 A.M. on the 20th; and new at 1 A.M. on the 28th. She is nearest us on the 4th, farthest off on the 19th, and nearest again on the 31st. As she circles the sky she passes near Jupiter on the 1st, Neptune on the 6th, Saturn on the 16th, Uranus on the 24th, Mars on the 25th, Mercury on the 27th, Jupiter again on the 29th, and finally Venus on the 30th of the month.

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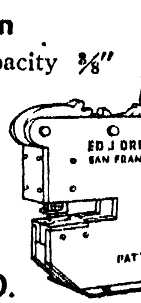

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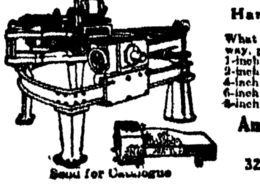

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Our Point of View

France and the Naval Program

(Continued from page 402)

sions that the 5 : 5 : 3 ratio applied to all classes. Australia, New Zealand, and Canada object as decidedly as we to an increase in Japan's auxiliary craft, but Great Britain is permitting our delegation to do the negotiating with Japan. If Japan proves obdurate, our only recourse will be to refuse to extend the agreement in the Far East in 1931.

Unquestionably both Great Britain and Japan are relying somewhat on our reluctance to spend the money necessary to create a navy, and they have some reason because of the ship-building program from 1921–1929 of the three countries, of cruisers, destroyers, and submarines, as shown in th table on page 402.

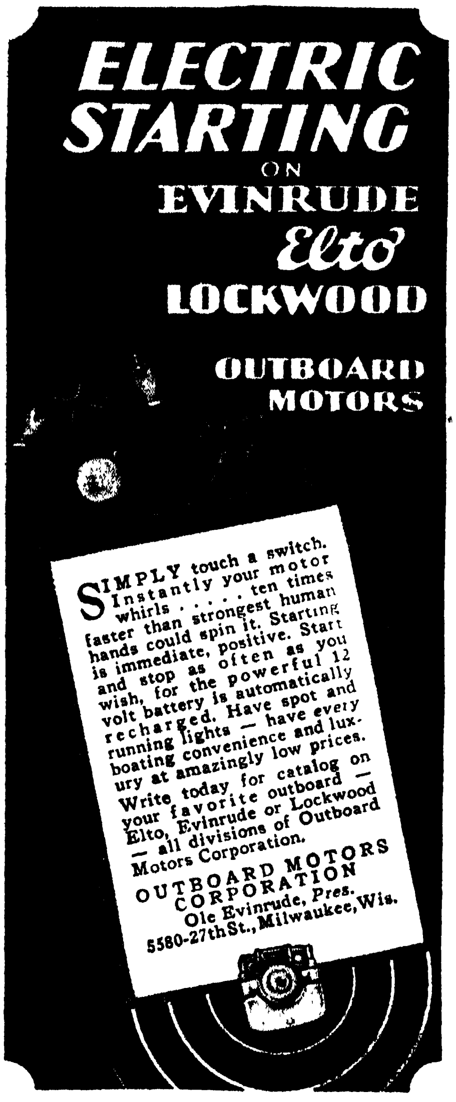
Thus since 1921, in the types of naval vessels not limited by the Washington Conference, Great Britain has built practically twice as many cruisers and Japan 40 percent more cruisers than the United States; in destroyers we have built none, while Great Britain has added 38,000 and Japan 74,000 tons. It should be added, however, that in 1921 we had a considerably larger number of modern destroyers than either Japan or Great Britain. In submarines, Japan has built over twice as many as Great Britain and 40 percent more than the United States. For eight years we practically refrained from adding to our fleet, with the result that except in capital ships we have been outbuilt by both Great Britain and Japan. If the Conference succeeds we will have to build to catch up with Great Britain and to regain the 5 : 3 ratio with Japan; if the Conference fails we will have to build still more or expose our commerce to the not over tender mercies of belligerent cruisers when we are neutral, or to the hostile action of enemy cruisers when we are a belligerent. As we go to press it looks as if the action of France would eventually decide the size of our Navy; to such curious results do international agreements lead.

Chemistry in Industry

(Continued from page 397)

M. R. Tern, of Zinnowitz, has lately been developing a process whereby the production of the sulfate is carried out without the use of sulfuric acid, and the process is said to have been successfully tried out on the large scale in Germany, where it has been attracting a good deal of attention.

The production of ammonium sulfate by passing ammonia gas through dilute sulfuric acid is such an old established process that no one but a German chemist would have thought it feasible to revolutionize the process. Dr. Tern's invention brings two gases together to form a shower of crystals, completely eliminating the saturators in which the ammonia gas is bubbled through acid. He produces sulfur dioxide gas by roasting the spent oxide, which is a waste product of the gas plant. Then he passes this gas through an electric arc, oxidizing it to sulfur trioxide. This gas then mixes with ammonia gas in an



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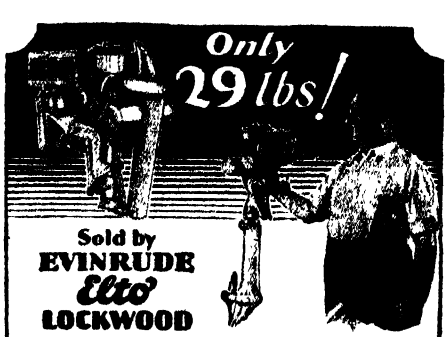

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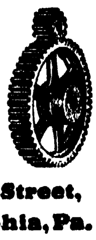

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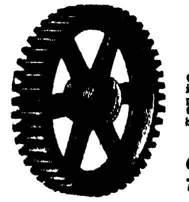

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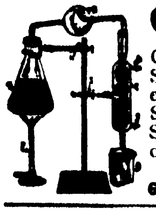

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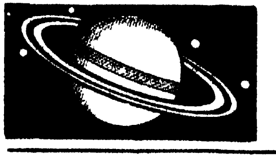

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Chemicals Do Not Fool Chickens

THE United States Department of Agriculture warns that no known drug or combination of drugs when fed to poultry will increase egg production. It has objected repeatedly to the use of any label on drug preparations for fowls which indicates that the preparations will increase egg production, and will continue actively its action against any preparations appearing in interstate commerce violating the law in this manner.

Enzyme in Bleaching Flour

GIVE us our daily bread and give it to us white, say Mr. and Mrs. American Public; wherefore flour millers, at the insistence of bakers, bleach the flour with chemicals before it goes on the market. This demand for white flour is largely a psychological one, for the carotin in wheat which normally colors it is entirely harmless and the bleached flour is neither purer nor more nutritious.

Until recently all flour-bleaching processes were based on rather potent oxidizing agents. Chemicals such as chlorine gas, nitrogen tri-chloride, nitrogen peroxide, and benzoyl peroxide are the oxidizing agents generally employed by flour millers for bleaching flour. Three of these are used in gaseous form, the fourth being a powder. In addition to their bleaching effect, all these bleaching agents effect an alteration in the baking characteristics (volume, grain, and texture) of the flour so treated. The chemicals effect the desired whitening of the color of the bread, but they also act on the flour protein, which forms the gluten of the dough. It follows that the flour is not only bleached by the bleaching agents but is also more or less modified in its other characteristics. Moderate treatment seems to improve the baking quality of the flour; over-treatment (overbleaching) may have undesirable effects in terms of its adaptability to yeast-bread production.

The latest development in the field of flour bleaching is the utilization of color-removing enzymes. The first compound containing these enzymes in activated form has just been announced under the trade name of "Do-White," a finely-ground, white-colored powder with a pleasing leguminous taste. Do-White is a pure, edible, plant product, containing no added chemical salts. It is partially soluble in water; in a small quantity of water it has a tendency to form a stiff jelly. Its active principle is an enzyme that has the ability to destroy or decolorize the natural, carotinoid pigment of flour. One half to one pound of it will completely

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bleach 100 pounds of unbleached flour when added to the ingredients in the dough mixer. Action is very rapid, the dough as it leaves the mixers being already considerably whitened. Bleaching continues throughout the fermentation, until the high heat of the oven during baking kills the enzyme. Like other enzymes, it is more active at high temperatures below its death-point, as in pan-proof, than it is at lower temperatures.

New Plastic Material from Cornstalks

OUT in the "corn belt," chemists have dreamed of converting the useless cornstalks into a useful article of commerce. Indeed, the dreams have been realized to a certain extent by the recent perfection of a process for making wall board from the stalks that were formerly useful only as Hallowe'en decorations. The most obvious use however, namely their conversion into paper, has thwarted the efforts of chemists, mainly because of the difficulty of overcoming the tendency of the pulp to hydrate, a property which seems characteristic of this material.

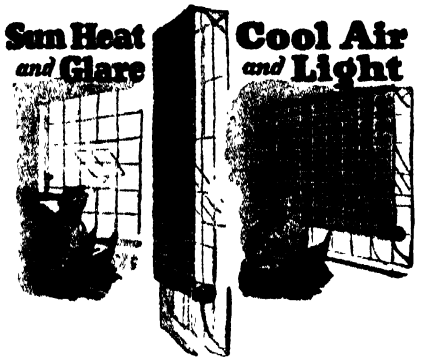
Scientists at Iowa State College finally hit upon the idea of turning this stumbling block into a benefit, and have produced a new material known as "maizolith." This material is somewhat like hard rubber in appearance and properties. It is believed that cornstalks may eventually find their way into the manufacture of insulating material, noiseless gears, and similar products. It has been found rather easy by severe chemical and mechanical treatment to hydrate the cornstalk completely so that the product is a jellylike mass with no vestige of fibrous structure. Maizolith is prepared by drying this jelly and then machining the finished piece into the desired shape.

Russian Chewing Gum Proves to be Rubber

A PLANT having a larval parasite which produces cocoons of a rubber-like substance has been discovered in Soviet Russia, following the search in that country for new sources of rubber, according to information obtained by the Department of Commerce from a Soviet publication. These cocoons have long been known to the local population and are used as a sort of chewing gum, but in the opinion of Soviet investigators they are thought to consist of rubber.

The constant development of the rubber industry in Soviet Russia has involved an increasing expenditure of foreign currency for the purchase of raw materials. Two methods have been suggested to remedy this situation: the manufacture of synthetic rubber and the cultivation of rubber-bearing plants. The Rezinotrest (the Russian rubber trust) has experimented in cultivating guayule shrubs in several of the southern regions of the Soviet Union, but these experiments cannot as yet be pronounced successful. Attempts have been made also to find other plants capable of producing rubber.

In Kazakstan, in the sands of Barkhan, several varieties of Chondrilla are found, which secrete a sort of rubber and which also is used by the Kazaks for chewing gum. This material has been examined by the Supreme Council of National Economy and Rezinotrest chemists, who classify the gum as rubber.



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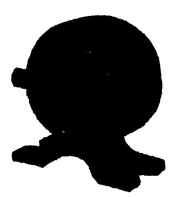

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THE fact that the Editorial Committee of the "Scientific Book Club" (a new scientific-book-of-the-month-club composed of five of the "biggest guns" in all American science) has chosen this book, is far from remarkable. Had they passed it up they would have merited boiling in red ink. Darrow, the author, has performed another of his periodic miracles of popularization, the best known previous "miracle" being his "Story of Chemistry" (1927) which in next to no time became a scientific best seller and roundly deserved that distinction. "The New World of Physical Discovery" is just as good as the other book (it couldn't be better). Darrow writes for a wide, not a special, audience, and his books are "comfortable" for the average mortal who wants instruction—yes—but interest also, and now and then some brightness, rather than a headache. The present book (358 pages) covers the whole of physics, both old and new, not merely the new. From it the reader will learn how physical science started; how it grew; what it is today; and *why* it is what it is. Authenticity, instruction, interest, legitimate romance, and again authenticity—these are its earmarks. $3.70 postpaid

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

American Corporations in Mexico

THE Supreme Court of Mexico has recently decided in a suit instituted by The Palmolive Company against an infringer of its trademark registrations in Mexico, that a foreign corporation, whether it be doing business in Mexico or not, is precluded from bringing suit in the Mexican Courts unless and until it is registered in the Commercial Registry. Such registration might be rather expensive, the fee depending largely on the amount of the capital of the corporation; thus, a corporation capitalized for 100,000 dollars would be required to pay from approximately 1000 to 1500 dollars for recording and legal fees. The registration referred to is not the registration of trademarks in Mexico but the registration of the corporation as doing business in Mexico.

The suit by The Palmolive Company was on its trademark, which had been duly registered in Mexico; actual infringement had been established but nevertheless the Supreme Court held that the plaintiff corporation has no standing in the Mexican Courts, because not being registered as doing business in Mexico, it has no existence in Mexico. This decision unless modified will have a far-reaching effect on the rights of American corporations in connection with their trademarks and other industrial property in Mexico. Although clearly erroneous, it will nevertheless be the law of Mexico unless it shall be set aside. The Department of Commerce has already laid the matter before our State Department.

Such a condition of affairs should not be permitted to continue. The Courts of every land should be open to afford complete relief to the owner of a registered trademark, and to prevent infringement thereof and imposition on the purchasing public by the substitution of the infringer's merchandise for that of the owner of the trademark.

Patents and Taxes

A RECENT decision of the Court of Claims in the matter of the claim of the Westclox Company for recovery of excess taxes paid by that company, reported in the *United States Daily* of February 6, 1930, is of considerable interest, not alone in showing that in computing income-and-profits taxes due consideration must be given to the advantages accruing to an industry because of patent protection, but also as outlining a rule for estimating the value of the savings resulting from the employment of the patented invention as compared with other processes and machines employed by competitors in the same line of business.

The patents covered a machine for automatically producing pinions and wheels, and also other patents for the design of the clocks manufactured by the claimant. Using as a basis the cost of producing ten thousand such wheels by the patented machine as compared with the machines and processes in use by others, the Court finally estimates the savings attributable to the patents; this is multiplied by the remaining life of the patents, in order to estimate the deduction which should have been made by the tax payer before computing the amount of its income-and-profits taxes.

In addition to the patents which were discussed, the value of the trademarks under which the clocks were sold was considered, and on the whole case as presented, the Court ordered that the parties compute the amount of the recovery and come to some stipulation with regard thereto.

This was a case where the patented inventions were not manufactured and sold, but offered protection only for the exclusive use of the machines employed in producing certain parts of the clocks. This is true, of course, excepting as to the Design Patents which covered the ornamental appearance of the clocks themselves.

If the protection of the exclusive right to use a certain machine, as compared with what one's competitor is compelled to use, is of so much value, it must follow that the exclusive patent protection for something that is manufactured and sold is of far more value. The theory on which the claim was allowed was that these protective patents were gradually expiring and that in time they would no longer be a source of profit to the owner, as upon their expiration the subject-matter thereof would be free to competitors.

Agreements Voided for Pooling Patents

THE United States District Court for the Northern District of Illinois has entered a decree in the so-called "oil-cracking case" by which agreements between several oil companies for pooling certain patents have been declared void. The case, as reported by the *United States Daily*, concerns agreements made between the Standard Oil Company of Indiana, the Texas Company, the Standard Oil Company of New Jersey, the Gasoline Products Company, *et al.* The patents involved covered processes and apparatus for producing gasoline by "cracking" petroleum. The agreements dealt with royalties for the use of such processes, as well as with the various patents. The suit was brought by the United States against the oil companies for alleged violation of the Sherman Anti-trust Law.

In addition to holding the agreements null and void, the court said: "It is further ordered, adjudged, and decreed that the primary defendants and the secondary defendants and each and all of their respective officers, directors, agents, servants, and employees, and all persons acting or claiming to act on behalf of them, or any of them, be, and they are perpetually enjoined and restrained from further executing and performing said agreements.

"It is further ordered, adjudged, and decreed that jurisdiction of this cause be retained by this court for the purpose of carrying out the terms of this decree."

Junior Applicant Wins Stoker Patent

RULING that the patent application of Chauncey L. C. Magee, covering certain improvements in mechanical stokers or grates, was filed after the invention had been disclosed to Magee by John C. Heavey, the Court of Customs and Patent Appeals has sustained the latter's claims. This decision confirms the opinion of the Commissioner of Patents, which had affirmed the decision of the examiners-in-chief, which in turn affirmed the decision of the examiner of interferences. All of the tribunals found that the junior party had disclosed the invention to the senior party, who had then filed application for a patent covering the device.

The appellant contended that the invention had originated with him, that the testimony of the junior applicant had failed to establish disclosure of the invention to him, and that the junior applicant's testimony had failed to overcome the prior record date of the Magee application. The courts, after investigating the facts involved, decided that Heavey had invented the device in question and had persuaded the manager of a large building in Chicago to have the apparatus installed by Magee, who was engaged in such work. It was disclosed that Magee had sent one of his draftsmen to Heavey to obtain the details of the apparatus. The equipment was made and installed, and Magee filed application for patent on the apparatus soon thereafter. Heavey filed application for patent some six months later, with the result that the Patent Office declared an interference to determine which of the claimants deserved the patent.

The invention relates to certain improvements in stokers or grates for furnaces of the type in which the grate bars travel through the furnace, supporting the fuel. The fuel is consumed as the grate moves. The particular improvement claimed consists of certain provisions for dividing the area of the moving grates into zones or sections for the purpose of supplying air upwardly through the different sections of the moving grate. This arrangement enables the air to be cut off from one section or zone and to be supplied to another by means of sliding dampers.

Court Finds Copyrighted Maps Were Copied

BECAUSE the maker of a composite map entitled, "Cleartype Road Map, Featuring Main Travel Routes within the Greater Metropolitan Area," had reproduced many errors, misspellings, and other peculiarities of certain maps copyrighted by the General Drafting Company, Inc., the District Court for the Southern District of New York ruled the defendant guilty of infringement. The case in suit was General Drafting Company, Inc., *versus* Lews H. Andrews, *et al.*

After pointing out that automobile road maps similar to those in suit are clearly the subject of copyright, the court appraised the method by which the maps had been prepared. It was found that the plaintiff had gone to considerable trouble and expense to prepare its maps, and had shown a noteworthy amount of originality in their preparation. The elements of the copyright consist, according to the court, in the selection, arrangement, and presentation of the component parts. The plaintiff's maps are sold in great numbers to the highway departments of several states, and to a number of the larger oil companies, for distribution to motorists.

The court ruled that if the defendant's map had been constructed after an independent investigation of the original sources in the public domain, without copying, the plaintiff would have no complaint. It was found, however, that the differences between the defendant's composite map and the several maps of the plaintiff were superficial. The defendant rested its case on the testimony of one Tudor, who described the manner in which he made the composite map. The testimony of this witness was shown to be of doubtful credibility, upon cross examination.

The case of the plaintiff was based upon the *prima facie* evidence showing the similarity, in unimportant and almost minute details, between the maps. Some 20 common misspellings were introduced, as well as 17 common errors in population symbols, the inadvertent misplacing of part of a river, arbitrary endings for roads at points actually not their endings, and the meanderings of highways, which in maps of this type are rather freely drawn. The court ruled that the defendant should pay damages and attorney's fees.

"Back of the Brawn, the Brain"

FROM a recent article in the *Journal of the Royal Society of Arts* (London), we are reprinting a tribute in verse to the world's inventors, and all those who design, build, and operate machinery.

"Back of the motors humming,
Back of the belts that sing,
Back of the hammers drumming,
Back of the cranes that swing,

"There is an eye which scans them,
Watching through stress and strain,
There is the Mind which plans them,
Back of the Brawn, the Brain."
—Berton Braley.

Wood Preservative Process Patented

ALTHOUGH the use of oil and sugar in treating wood is not new, patent has been awarded to George Elton Rice (Number 1732420) for a process of treating wood with oil and sugar which involves a function not present in the prior art and eliminates one step from the prior art processes. This decision of the Board of Appeals of the Patent Office, *ex parte* George Elton Rice, held that the examiner improperly rejected claims in an application for patent, because none of the references cited anticipate the process claims which cover the dehydrating as well as the impregnating of wood by treatment with a solution which contains oil and sugar.

Although it is old to preserve wood by impregnating it with preservatives carried in oil, and it is also old to preserve it by impregnating it with sugar in aqueous solution, the applicant had substituted oil for water with sugar and in so doing eliminated the necessity of drying the wood either before or after the impregnation process. This process involves more than the mere substitution of one preservative for another, in view of the fact that the drying process or step is eliminated. In the absence of any showing by the examiner that the result urged by the appellant is old or obvious, the claims were considered valid and allowable.

Patent Holder Must Give Notice of Alleged Infringement

THE owner of a patented article must give notice of his right therein, either to the public by marking his article "patented" or to the particular defendant by informing him of its infringement. Unless this is done, according to the District Court for the Western District of Pennsylvania in General Electric Company *versus* George J. Hagan Company, the owner of the patent may not obtain an accounting for damages and profits, even though the infringer had knowledge of the patent for several years and had built the devices for a time under a license.

The suit was tried on submission of decree for profits and damages for infringement of claims 7 to 11 of patent Number 1310060 to Collins for an electric resistance furnace. The court found that the defendant had knowledge of plaintiff's patent in 1919. Under an oral license from the plaintiff, the defendant built furnaces from 1919 to 1923, then conducted negotiations about a renewal license. It was found that at no time did the plaintiff comply with the statutory provisions of notice to the public by marking, and at no time did the plaintiff either verbally or in writing notify the defendant that it was infringing the patent in suit. It was held, therefore, that the plaintiff was not entitled to an accounting for profits and damages.

Section 4900 of the Revised Statutes, title 35, section 49, reads: "Patented articles marked as such; notice of infringement.—It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented; either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, this can not be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented."

Patents Recently Issued

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Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co., those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

Airplane Wing—The surface of which is made in a plurality of sections arranged in stepped relation affording air passages between the sections which, incident to the velocity of the plane, creates a maximum vacuum over the entire wing surface. Patent 1746140. Jarrot Bobo.

Aeroplane Steering Mechanism—A combined steering mechanism and joy stick whereby an aeroplane may be controlled in flight in the usual manner or steered on the ground, and manually operable means for locking the wheels in landing position. Patent 1747344. Harry S. Bell.

Aeroplane—Having a water tight fuselage, and equipped with a parachute and means for releasing the forepart of the plane from the fuselage so that the latter will be permitted to slowly descend in case of trouble. Patent 1748811. Charles C. Warren.

Pontoon for Airplanes—Providing means whereby an airplane may be used as a hydroplane, the pontoons being equipped with retractable wheels, which may be drawn for travel on the ground surface, thus combining several body units in one assembly. Patent 1747563. Joseph G. Yonkese.

Control Mechanism for Aircraft—Whereby a slight movement of the joy stick will enable the pilot to handle and control the elevators, rudders and ailerons of a large passenger carrying plane as easily as a small scout machine. Patent 1747564. Joseph G. Yonkese.

Empennage Structure for Aircraft—More particularly adapted for large double bodied aircraft, wherein means is provided for guiding the craft when rising or alighting, the operating mechanism being particularly strong, and enclosed in such manner as to present a smooth stream-line box-tail construction. Patent 1747565. Joseph G. Yonkese.

Pertaining to Apparel

Heel Grip—Of resilient material, shaped to the contour of the heel so that in its movement it will cause the boot or shoe to move almost as if it formed an integral part of the foot. Patent 1745726. Chester R. Snow.

Chemical Processes

Process of Making Fuel Mixtures—Which comprises passing acetylene gas through pentane, whereby the acetylene gas will act as a vehicle for carrying predetermined quantities of the pentane, and so modify the mixture that the flame will give off no carbon monoxide. Patent 1746172. Paul E. and Frank A. Webb.

PROCESS FOR RETTING TEXTILE FIBERS—Consisting in agitating raw fibers from flax, or other vascular fibers, for about fifteen minutes in water and nitrogen fixing bacteria at 100 degrees Fahrenheit, letting the fibers remain immersed for three hours, draining, and drying the fibers. Patent 1746316. Morris Marcus.

Designs

DESIGN FOR A KEY TAG—Patent 80435. Benjamin C. Da Shiell.

DESIGN FOR A DOLL HEAD OR SIMILAR ARTICLE—Patent 80481. Adolph Gramlich.

DESIGN FOR A GOBLET—Patent 80512. George Dougherty.

DESIGN FOR A TOY SOLDIER—Patent 80531. Peter J. Hemmer.

DESIGN FOR DISH OR SIMILAR ARTICLE—The inventor has been granted four patents for ornamental designs of a similar nature. Patents 80520, 80521, 80522 and 80523. William P. Graham.

DESIGN FOR A DRESS—Patent 80574. Dorothy Long.

DESIGN FOR A COASTER—Patent 80591. Albert S. Valchek.

Electrical Devices

DYNAMIC RADIO RECEIVER AND AMPLIFIER—A transformer especially adapted for radio, providing a simple and efficient receiving circuit in conjunction with an amplifier which does away with the use of a battery and vacuum tubes and gives greater amplification. Patent 1747137. George Wald.

ELECTROSTATIC LOUD-SPEAKER—Wherein a soft ductile membrane co-operates with a rigid perforated metallic plate, the perforations being parabolic so that even with large amplitude vibrations the electrostatic forces upon the membrane remain proportional to the applied electrical amplitudes. Patent 1747952. Eugen Reisz.

MEMBRANE FOR ELECTROSTATIC LOUD-SPEAKER—A process for manufacturing a metallic coated insulating membrane which includes the step of sticking metallic foil coating upon the rubber or other insulating membrane by means of a vegetable or castor oil. Patent 1748901. Eugen Reisz.

Of Interest to Farmers

CULTIVATOR ATTACHMENT—Having a plurality of rotatable earth working elements which may be simultaneously adjusted to various angles with respect to the path of travel, particularly adapted for side hill cultivation. Patent 1747058. Daniel W. Duellman.

CULTIVATOR—Having an angularly disposed wing at the side, by means of which grass and other vegetation may be uprooted from the ground in close proximity to the roots of growing plants, while the row is being cultivated. Patent 1747059. George F. Dugger.

STOCK MUZZLE—Having means whereby the size of the central feeding opening may be quickly adjusted to permit the animal to bite off more or less grass, according to the height, and thus prevent dangerous bloating. Patent 1748027. Chris M. Rasmussen.

Of General Interest

JEWELER'S TAG—Of bendable material, which may be easily connected with an article of jewelery, and if desired easily removed for use on another article, a button structure securing the tag in folded position. Patent 1742982. Charles T. Wittstein.

ROAD AND STREET CONSTRUCTION—In which the road base is covered with bituminous rock, or a mixture of bituminous rock and clean hard stone, forming a levelling course, after which the wearing surface is formed of ground bituminus rock rolled cold. Patent 1747125. Guy F. Murphy.

STRUCTURAL FORM FOR CONCRETE WORK—A metal form framing and retaining unit of general application and use in the building of walls, stairs, columns and the like, wherein the form serves as molds within which the concrete is poured and held until set. Patent 1747086. John H. Sullivan.

REFRIGERATING SYSTEM — Particularly adapted for cooling syrup cans in soda fountains, the cooling mechanism taking up a minimum space, high pressure in one refrigerant being utilized to force the liquid through an additional cooling line to other containers. Patent 1746896. Franklin B. Hunt.

CARD HOLDER—Which may be permanently fixed to a trunk, box or package, in such a manner that a card may be inserted or removed at will, a holding means retaining the card against accidental displacement. Patent 1747077. Irwin M. Ikelheimer.

ICE-CREAM HOLDER—Which can be conveniently handled without soiling the hands from the melting cream, and which will be edible constituting in effect an ice-cream sandwich having a handle for holding the same. Patent 1747112. Warren E. Good.

HAND PROTECTOR—A covering guard particularly designed as a shield for the hand when manipulating a spoon in basting meat, or a fork or other culinary implement in the presence of hot grease or steam. Patent 1747097. Alvah D. Young.

RACK FOR PIECE GOODS—Especially designed for holding bolts of cloth or goods on shelving in the aisles of stores so that the goods may be conveniently displayed to prospective customers, thereby reducing to a minimum the handling of the goods. Patent 1747026. William W. Phillips.

COLLAPSIBLE CASE—Simulating the commonly known suit case, having a plurality of sections which enable the case to be enlarged or contracted, operating with equal facility at any adjustment, the handle being positioned according to the weight within the case. Patent 1748024. William W Machemer

COMBINED SOAP HOLDER AND MASSAGING DEVICE—Functioning as a soap cup of sponge rubber, having in addition one face with projections and the other face formed as a receptacle for soap with a pair of spaced handles permitting a secure grip for massaging. Patent 1748008. Harry Barnowitz.

CURTAIN AND SHADE GUARD—In the form of a rod and brackets whereby curtains and shades may be kept from being soiled by the action of rain and dirt, and to tearing action on being blown outside of the room. Patent 1746269. Henry W. and Margaret Lupton.

VACUUM CLEANER ATTACHMENT—Whereby one of the two hooks, usually attached to the handle for holding the electric cord when not extended in use, may be swingable, so that the cord may be instantly released without unwinding Patent 1746246. Frederick W. Elworthy.

TIE WIRE AND SPREADER—An elongated member having eyelets which may be secured to forms for concrete, and the like, at a number of points, thereby strengthening the connections between the inside form and the outside form. Patent 1746298. Charles M. Ally.

PLANT PROTECTOR—For protecting young plants against destructive insect and worm life, as well as against injurious cold weather or frost, designed to hold more moisture in the soil about the roots that is usually possible. Patent 1747967. Robert B. Bell.

EXPANSION PLUG FOR PIPES—Having an expansion head adapted to effect a closure of the pipe, and in which ample clearance, irrespective of elbow bends, is provided for the operation involved in expanding the head. Patent 1747988. Patrick Goodman and Beni Leone.

FIRE HOSE—Characterized by properties of high resistance, reinforced against permanent creasing which results in rapid deterioration and cracking, and reinforced against wear while being drawn over the ground or conveyed within the hose wagon. Patent 1747584. Russell P. Howard.

JUICE EXTRACTOR—Embodying a cutter for dividing the fruit and a receptacle in which the extracted juice and pulp of oranges, lemons or limes is collected, and the juice strained from the pulp before being discharged. Patent 1747641. Robert C. Morris.

VACUUM CLEANER—Including a wheeled carriage constituting a solid base for electric motor and blower, is relatively small and compact, can be conveniently carried from place to place or may be readily stored within the carriage. Patent 1748853. Etta M. Squires.

Hardware and Tools

PIVOT-STRAIGHTENING DEVICE—Particularly adapted for straightening the balance staff pivots and train pivots of watches, a tool with which accurate temperatures are assured, and which may be manipulated with the thumb and fingers without burning the hand. Patent 1747136. George F. Putnam.

CAN OPENER—Comprising a pair of handles, a cutter and a can-moving wheel, the cutter being riveted at two points will not work loose, and the movement of the can-moving wheel away from the cutter is limited. Patent 1744573. Axel W. Peterson.

BED-RAIL CONNECTER—So constructed as to render the side bed rails reversible to accommodate flat bed springs or coil or box bed springs, each being supported at the same level on the bed frame. Patent 1745653. Adolf Weston.

TRUNK LOCK—Comprising threaded means adapted to be secured to the trunk body in spanning relation to its door opening, for providing a fluid tight joint between the closure and the truck body and effectively lock the closure. Patent 1745422. Charles Hinde.

VISE—A portable tool with means for attachment to a bench, a pair of jaws of the screw adjustable type to function as a wrench when detached from its support, thereby being usable under varying conditions. Patent 1748886. Abelardo Linares.

SCREW ADJUSTABLE MECHANISM—A combination tool, combining a wrench structure with a support for its fixed jaw, and a hanger or jacking element for its movable jaw, to form a jack, the parts being separable for storage or shipment. Patent 1748888. Abelardo Linares.

INTERMITTENT-GRIP DEVICE—A rotatable element having a ratchet wheel thereon, and a detachably mounted handle and co-operating pawl element, said member being demountable for convenience in storage or shipment, and being reversible for effecting reverse rotation. Patent 1748887. Abelardo Linares.

Heating and Lighting

GRATE—Wherein a maximum natural draught will keep the interchangeable grate elements in a cool state, the construction being such as to give a maximum life to the grate, and a more perfect combustion to the fuel. Patent 1746126. Morton K. Moore.

APPARATUS FOR MAKING ILLUMINATING AND HEATING GAS—In which compressed air is forced through gasoline or oil, whereby a combustible gas is produced and stored in confined space, before being conducted to the burners or any form of motor power operated by gas. Patent 1747094. John Whikehart.

Machines and Mechanical Devices

SLIP FLASK—For molds, wherein the alignment and holding of the cope in proper position on the drag receives special attention, the planks of the flask being so clamped and reinforced as to prolong their period of usefulness. Patent 1746146. Adam Diehl.

SNOWPLOW—Of the type adapted for use with tractors, whereby the necessary parts may be controlled by the operator from his seat, effective means being provided for gathering and delivering snow on either or both sides. Patent 1746167. Richard Robertson.

Cotton-Feeder Mechanism—For cotton cleaners, burr extractors, boll breakers, etc., which is entirely automatic, the speed of the feed being regulated with extreme accuracy by the pressure of the cotton in the roll box. Patent 1746185. Jackson L. Walker.

Paint Stirring and Mixing Device—Including a rotary blade and manipulating crank, adapted to be attached to a paint can for facilitating the stirring and remixing of the liquid and solid ingredients, after they have settled in the container. Patent 1747032. Frederick Schlageter and Fabian Maletsky.

Mechanism for Cutting and Facilitating the Removal of Material from Machines—A machine for manufacturing noodles, which insures the separation and cutting of the noodles into uniform quantities, thus obviating the necessity of weighing, means being provided for their removal without physical contact, whereby sanitation is insured. Patent 1747075. Joseph Horowitz.

Ball-and Socket Joint—Which is simple in construction, easy to assemble and effective in operation, and is particularly useful in lubricating systems in lieu of flexible tubing. Patent 1745755. Coy C. Goodrich.

Glass-Gob Cutter—Adapted to be positioned near the outflow of glass from a melting tank, for cutting the glass gobs, at right or various angles by a liquid or gaseous substance, without leaving any visable mark. Patent 1747087. Charles H. Schlalz.

Surfacing Machine—For finishing the interior of manhole casings, a portable machine which is rotatably supported on the work, and incident to its rotation about the same, automatically feeds a cutting element evenly over the entire surface. Patent 1747944. Charles H. Lyne.

Wave Motor—Which is characterized by its responsiveness to record every impulse of the water due to wave motion, roll, weight of water and undertow, and to convert such impulses into power to perform useful work. Patent 1746613. Chester E. Shuler.

Developing Rack—A manually rotatable disk support, whereon photographic films may be detachably held without contacting with each other, and may be passed through the developing, washing, fixing, and washing processes, and eventually dried by centrifugal action. Patent 1747930. Irving L. Cook.

Harness-Tape-Selvage Motion for Looms—A salvage harness so constructed that it may be used with the heddles used in connection with the usual harness, reducing wear of the parts to a minimum, and is readily removable for retying warps. Patent 1748001. Edward P. Taft, Payton L. Videtto, and James A. Gaddy.

Automatic Control for Well-Flowing Devices—Wherein no delicate springs or other unsubstantial elements are used to urge the plunger or valve element to an open position or to resist its action in closing, the action being governed by the velocity of the liquid column, is therefore positive in operation. The inventor has been granted three patents of a simular nature, Nos. 1747570, 1747571 and 1747572. Alexander Boynton.

Current Motor—Particularly adapted for use in bodies of flowing water, such as rivers or streams, is capable of being adjusted with respect to the direction of the water, whereby the power of the flow may be utilized. Patent 1745356. William H. Crofton.

Valve Mechanism—For air compressors, functioning as either an inlet or outlet valve means, comprising a cup shaped element having an axially disposed duct there through and a flat annular valve seat surrounding the inner end of the duct. Patent 1746612. Elmer F. Seager.

Gas-Orifice Meter-Chart Calculating Machine—By which the pressure and differential curves of such charts are employed as indices for the production of a computation of the quantity of fuel that has passed through an orifice during any determined period. Patent 1748783.* John B. McGaughy.

Graduated Magnetic Control of Brakes or Clutches—A brake mechanism having means for controlling the same, whereby the brake may be either gradually or quickly applied and held at any degree of application, by combined electromagnetic and fluid operated means. Patent 1748773. Frank L. Johnston.

Margin-Adjusting Device for Writing Machines—Adapted for open front paper carriage machines, whereby the margin may be set and fixed by displacing the carriage as a whole, or may be locked on the carriage or left free to slide. Patent 1748896. Camillo Olivetti.

Apparatus for Applying Soft-Metal Linings to Hard-Metal Tubes—Which facilitates the application of soft metal, such as lead, to hard metal tubes, the lining operation being continuous, and the lining uniform, without necessitating subsequent finishing operations. Patent 1748851. Warren R. Smith.

Dish-Washing Machine—By means of which dishes of various sizes, as well as table silver, may be washed and rinsed thoroughly and rapidly, the soiled dishes being continuously fed to the machine. Patent 1748530. Aurelio R. Torres.

Musical Devices

Piano—Wherein the percussion strokes of the hammers are automatically shortened or lengthened correspondingly with the actuation of the soft pedal control, and a greater range of volume and tone is obtained, with precision not heretofore possible. Patent 1748777. Bernhard F. Laukandt.

Plumbing and Fittings

Faucet Fitting—Comprising a pipe divided interiorly into passages, and outlet ports for separately conducting hot and cold water to a single nozzle, the valve seats are readily accessible for replacement when necessary. Patent 1747640. George J. Morris.

Prime Movers and Their Accessories

Safety Device for Liquid-Supply Lines—Adapted for use in preventing failure of a supply of fuel for internal combustion engines, in the event of a break or other source of leakage in the supply line, particularly adapted for air craft. Patent 1746095. Frank E. Tugwell.

Valve Construction—Which has means for receiving the general formation of carbon and directing the same so that it will not interfere with the valve operation, the contacting portions being out of the path of the exhaust gases may be lubricated. Patent 1746927. Carl F. Burgmann.

Railways and their Accessories

Railroad Tie—A tie structure in which both sections are identical, whereby any two sections may be properly mated, eliminating the number of operations required for the production of a complete tie, thereby effecting economy in labor. Patent 1747054. George B. Cox.

Wheel-Flange Lubricator—Using grease in stick form for lubricating the flanges of railway cars, locomotives, street cars or other vehicles running on rails, whereby the lubricant will be constantly applied, and the stick easily replenished. Patent 1748028. Lester J. Rickard.

Hinged Top for Box Cars—By means of which the entire top of the car may be opened, permitting the use of cranes, instead of human effort, for unloading, resulting in cheaper handling, the construction forms an entirely watertight closure. Patent 1747423. Blair B. Campbell.

Pertaining to Recreation

Toy—A combat device in the form of two boxers or fencers, the arms of the figures being manually operable to deliver or parry blows, and to automatically become inoperative when the target portion of the body has been struck. Patent 1745484. John F. McIntosh.

Swimming Appliance—In the form of a glove with rubber webbing, or the like between the fingers and thumb, as an aid in swimming, and to increase the effectiveness of the propelling stroke. Patent 1748317. Thomas B. Sykes.

Pertaining to Vehicles

Visor for Motor Vehicles—Having a window and a shutter, and means within reach of the driver for regulating the vision area of the window whereby an unobstructed view of elevated traffic signals may be had. Patent 1745197. Joseph E. Tirpak.

Cylinder Grinder—Which may be secured to the engine block, and has means for automatically centering the mechanism within the cylinder for grinding automobile motor cylinders, without removing the motor from the chassis. Patent 1745015. John Johnson.

Brake Equalizing and Operating Mechanism—For vehicles, comprising a plurality of brake actuating members and a wedge-shaped member contacting therewith, the wedge-shaped member having a slight rotative motion and means for imparting endwise motion for operating the brake members. Patent 1744643. Nicholas A. Kristmann.

Method of Making Tires—A built up tread portion for pneumatic tires comprising a central section of annular fabric rings and alternate annular rubber tread webs, their edges forming a wearing surface which will prevent lateral slipping. Patent 1744025. Virgil C. Anderson.

Oil-Gauge-Rod Wiper—For use in connection with cleaning automobile gauge rods, before use in testing the amount of oil in a crank case, whereby the wiping may be accomplished by a single stroke, without the operator handling the wiper. Patent 1747100. Alton W. Ashworth.

Foot Control for Motor Cars—Adjustable to a given point in a range of settings for the throttle valve of the carburetor, and when adjusted may be left at that point so that the speed of the car will be substantially held. Patent 1747083. Henry J. Ries.

Blow-Off Gauge—Adapted to be applied to the valve stem of an inflated tire for allowing only a predetermined amount of air under pressure to pass the valve stem, having a novel means for forming an air-tight connection. Patent 1746923. Esten B. Beeler.

Water Gauge for Automobile Radiators—Having a supportng plate and a floating member with signs indicating the water level, the entire formation covering only a part of the radiator opening, thereby permitting water to be inserted while the gauge is in use. Patent 1747022. Albrecht zur Nieden.

Collapsible Wheel Chuck—A block which will be strong, yet can be carried in a relatively small space, opened and placed in operative position under and at the rear of a wheel, to prevent any possible movement of the wheel. Patent 1746415. Joseph A. Burkart.

Three-Wheel Vehicle Chassis—Having means for moving the front wheel slightly to one side when turning to carry the weight directly to the ball bearings removing the strain from the chassis and preventing the device from turning over. Patent 1747526. Ernest L. Pearson.

Antiglare Device—Which is applicable to automobiles of the closed or open type, and when in applied position may be adjusted to effectively intercept glare producing lights, yet permit an unobstructed vision of the roadway. Patent 1745695. William O. Hunter.

Rumble-Seat Top—Wherein a top and sides are provided and so arranged that the top may be used alone or in connection with the sides, thereby providing a complete enclosure, the cover is removably connected. Patent 1748081. Julius N. Wiener and Henry Aretsky.

Bus Seat Switch—A double deck bus, wherein the operator may act as driver and conductor, all passengers being compelled to pass him in entering and leaving, and a signalling device indicating the vacant seats on the upper deck. Patent 1747960. Charles Weiss.

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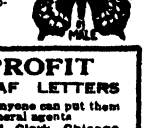

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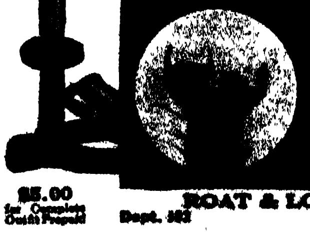

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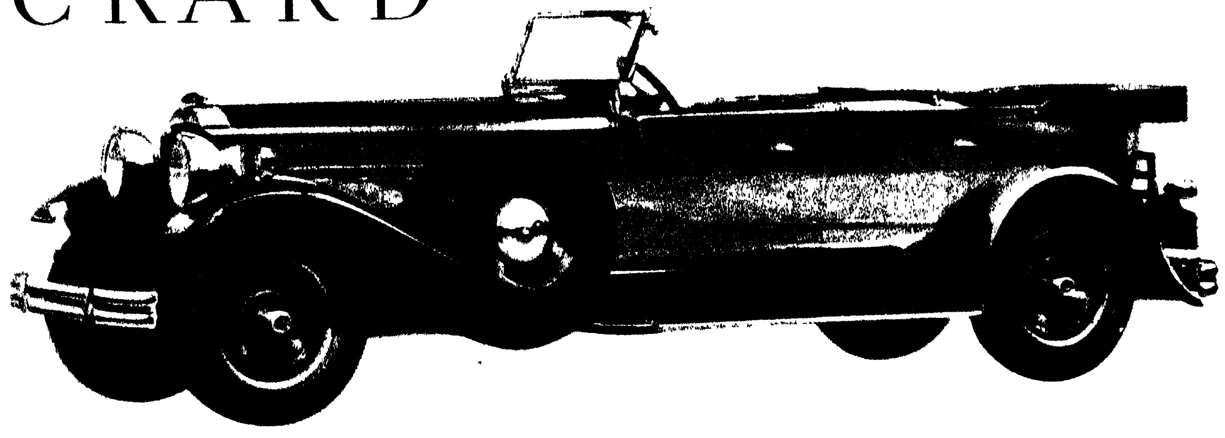

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SCIENTIFIC AMERICAN

June 1930

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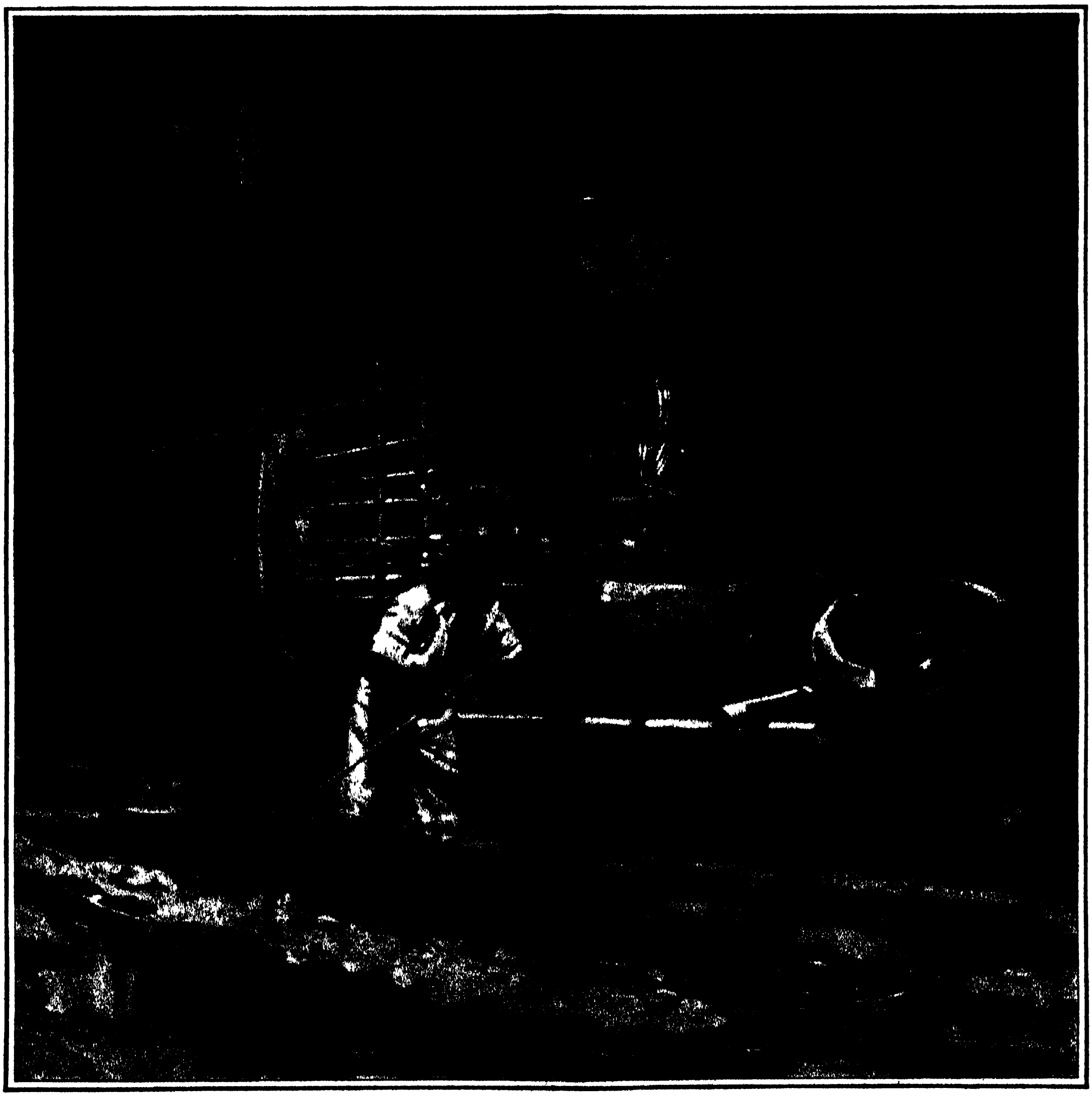
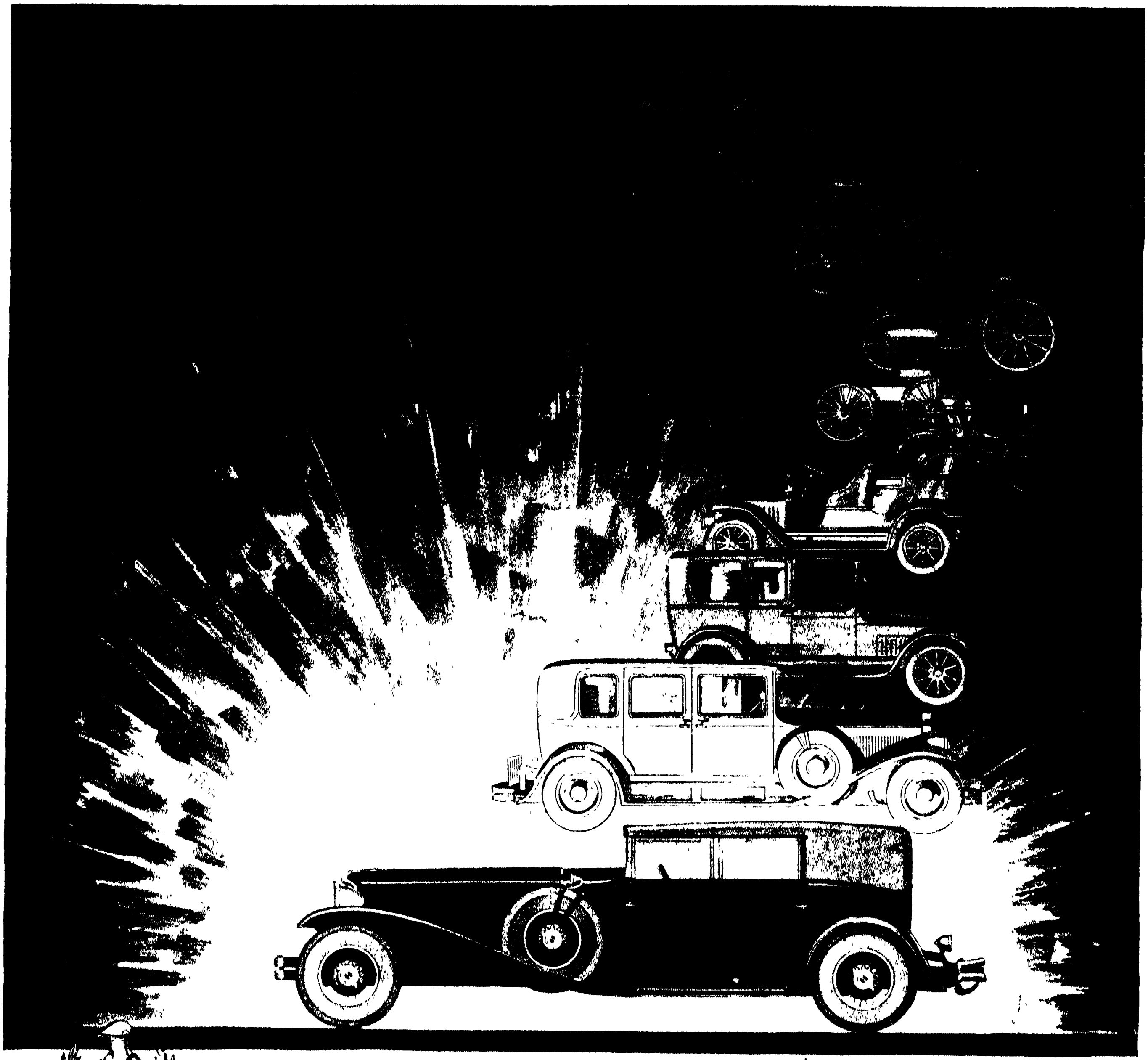


Primitive Methods Used in Modern Copra Industry



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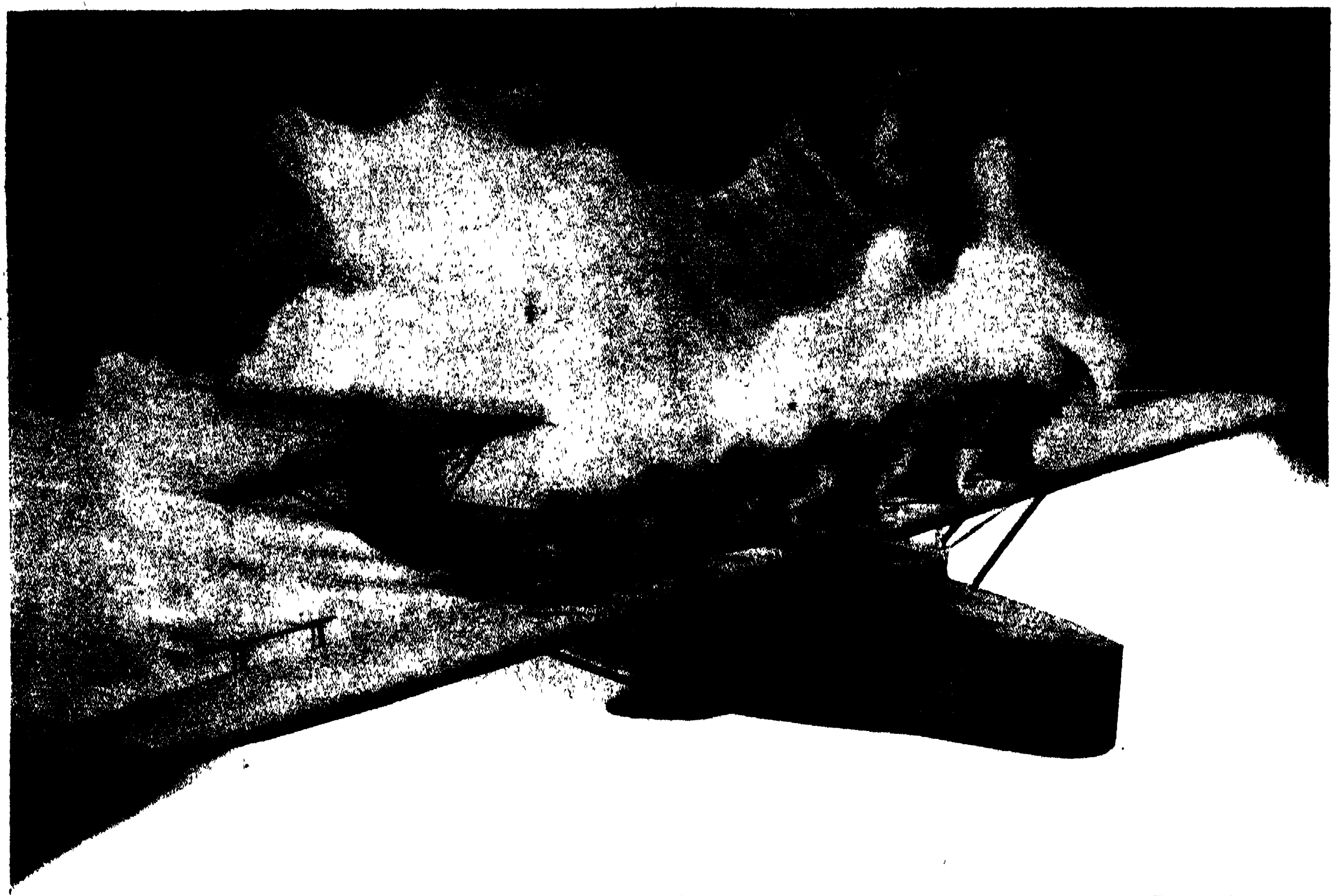

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are on this, the Largest Airplane in the World

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No time to *wish* that the bearings had been purchased upon performance rather than upon price . . . not when the twelve roaring motors on the wing will continue to roar *only* so long as the bearings stand up . . . nor when the twenty-four engine generators are running on them, and lighting dynamo, radio installation and fuel pump depend upon them.

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Germany's giant 100 passenger plane is powered with 12 SKF equipped Siemens Jupiter* engines. SKF Bearings take the propeller thrusts and are on the crankshafts, Farmantype reduction gears, magnetos, lighting dynamo, radio and Lenz pump—a total of 149.

*NOTE: Recent press dispatches state that 12 SKF equipped Curtiss-Wright engines will be installed for the Trans-Atlantic flight of the DO-X.

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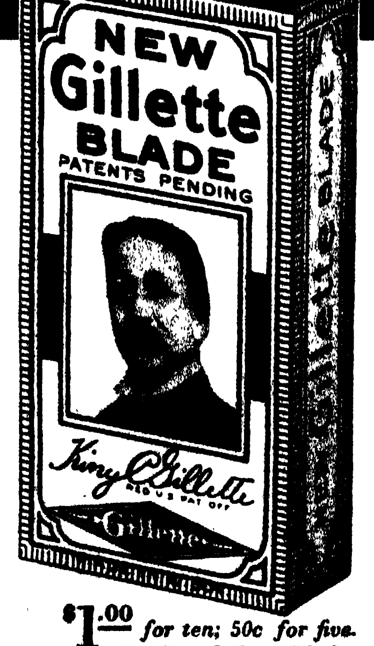

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SCIENTIFIC AMERICAN

June, 1930 **ORSON D. MUNN, *Editor*** ***Eighty-sixth Year***

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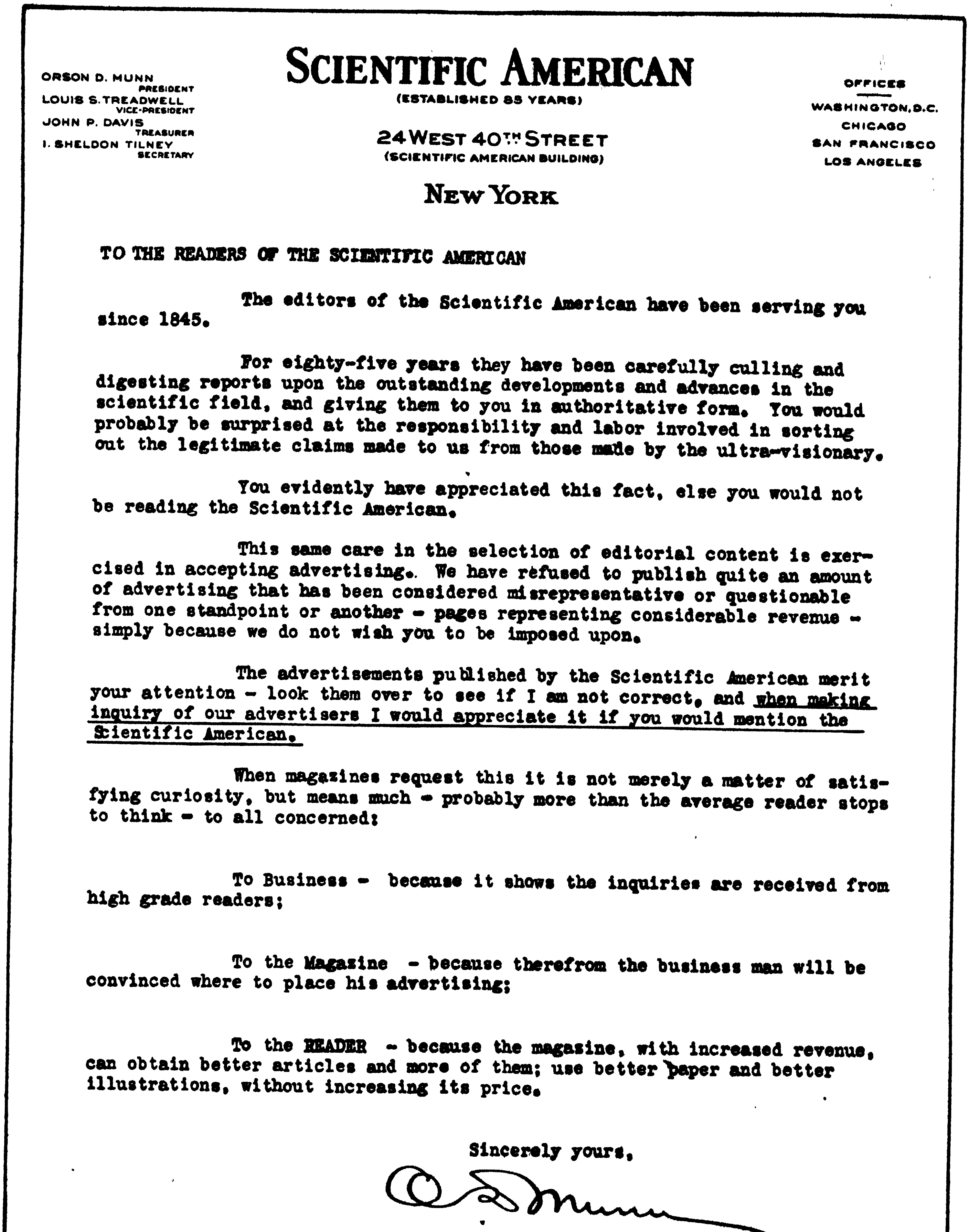
COVER

In the copra industry in the Philippine Islands, the primitive meets the modern. From the hinterland the natives bring their harvest of coconuts—by means of crude carts of the type illustrated by Howard V. Brown on our cover—to the modern extraction plants where the coconut meat is dried, and the resulting copra is pressed to remove the valuable coconut oil. The interesting story of this industry, which has a bearing on our everyday lives through soaps and many other familiar products, is told in the article starting on page 432.



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LOS ANGELES

TO THE READERS OF THE SCIENTIFIC AMERICAN

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Sincerely yours,

O D Munn

Publisher

Looking Ahead *With the* Editor

Meydum Pyramid

WHETHER he knew it or not, Seneferu, first really great historic king of Egypt who died about 2900 B.C. was a past master of publicity. Fifteen hundred years before Christ, the mighty pharaohs used to boast of their exploits that "nothing like it has been done since Seneferu!" Father of Cheops, who built the Great Pyramid, Seneferu was also a great builder, as will be shown in a coming article on the excavations at Meydum.

Sleep

"IT is abnormal for a healthy sleeper to lie in any one position for a long time," is just one of the important findings of the sleep posture research conducted by the Mellon Institute to be reviewed at some length in these pages soon. A movie camera and elaborate mechanical and electrical devices were used in this research which discovered many new facts to replace old theories and suppositions concerning sleep.

Life and Death

IN structure, the living organism is identical with the non-living. What, then, is lost in death? No one knows perhaps never will know. A widely known man of science, however, has worked out a sound theory on the nature of life and death which he has outlined in an article which we shall publish soon. In it, he includes a readable description of the many experiments which were conducted in working out his hypothesis.

Waves and Particles

BREAK a piece of chalk into two pieces. Break each piece again, and then again; continue the process. Is there any theoretical limit to our progress? This puzzle has been studied by science throughout the ages and science still theorizes. It is the question of the ultimate nature of matter—the structure of the atom. The evidence of experiment, according to an article ready for release, has forced a drastic revision of the concept of the nature of matter.

Tool-proof

COOK COUNTY JAIL, recently completed in Chicago, is said to be the largest and most up-to-date prison in this country. A description of it, which we will publish soon, will tell of some of its most important features including its "telephone pole" arrangement, its mechanical remote control of cell doors, its chisel- and saw-proof steel, and its connection with the Criminal Court Building, also a distinctive design.

Every Issue Fully Illustrated

¶ *The well-informed man or woman is the one who progresses. Why not let the* SCIENTIFIC AMERICAN *bring to you the latest news of the scientific world in general? The cost is nominal—only four dollars for an entire year's subscription.*

Among Our Contributors

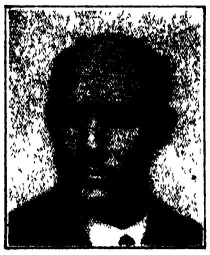
Edward S. Evans

STOREKEEPER, cowpuncher, farmer, assistant state librarian, real estate agent, and law student: Mr. Evans tried his hand at all of these before achieving his present prominent position in the business world. In addition to being president of the Detroit Aircraft Corporation, he is president of another large company, president and treasurer of another, honorary president of the National Glider Association, and holds other important positions. He achieved international prominence in 1927 when he made a record dash around the world in 28 days, 11,000 miles of his route being covered by airplane.

Paul R. Heyl

AGAIN in this issue we have one of the particularly clear and analytical articles by Dr. Heyl, who needs no further introduction to our readers. In "Is There An Ether?" he reviews a question which has puzzled man for ages and, in modern times, has caused considerable controversy.

J. G. Crowther



ANYONE who knows of the world-wide prestige of the *Manchester Guardian*, of Manchester, England, can realize the significance of the fact that Mr. Crowther is the scientific correspondent of that newspaper. Mr. Crowther's popular book, "Science for You," published in America by Brentano, was enthusiastically praised by an outstanding American man of science. He has just published a second: "Short Stories of Science."

Thomas T. Read

DR. READ'S activities have taken in many phases of mining. Several times he has been a professor of mining and metallurgy at different institutions and is now professor of mining at Columbia University. He has been an associate editor of a publication on mining, chief of the service division of a large zinc company, with the United States Bureau of Mines in the Department of Educational Information and later as Director of Safety Service, and has written much on mining and metallurgy.

INDUSTRIAL LOS ANGELES

CENTRAL STATION POWER COSTS LESS IN LOS ANGELES*

*The bills of a representative number of large and small typical industrial consumers were computed at Los Angeles rates and principal published rates in Eastern and Midwestern industrial centers and found to average 46.5% lower in Los Angeles.

This Means Lower Production Costs than at Your Eastern or Mid-Western Factory!

THE RECOMMENDATIONS of an imposing number of nationally famous industrial engineers have resulted in the construction of many Pacific Coast factories in the Los Angeles area on the basis of savings in production costs. Analysis of the Los Angeles cost sheet shows that power here is a potent factor in economical production... a worthy helpmate to unsurpassed advantages of distribution, market concentration, accessibility to South America and the Orient, productive climate and labor, and low building costs.

Compare your present power costs with savings available in this industrial center. Send detailed specifications of your prospective Pacific Coast plant requirements. An accurate computation of what your Los Angeles power costs would be here will be returned to you promptly... compiled by thoroughly experienced industrial power experts. Our opening statement is a challenge. Write the Business Agent, Bureau of Power and Light, 207 South Broadway, Los Angeles, California, for your confidential report.

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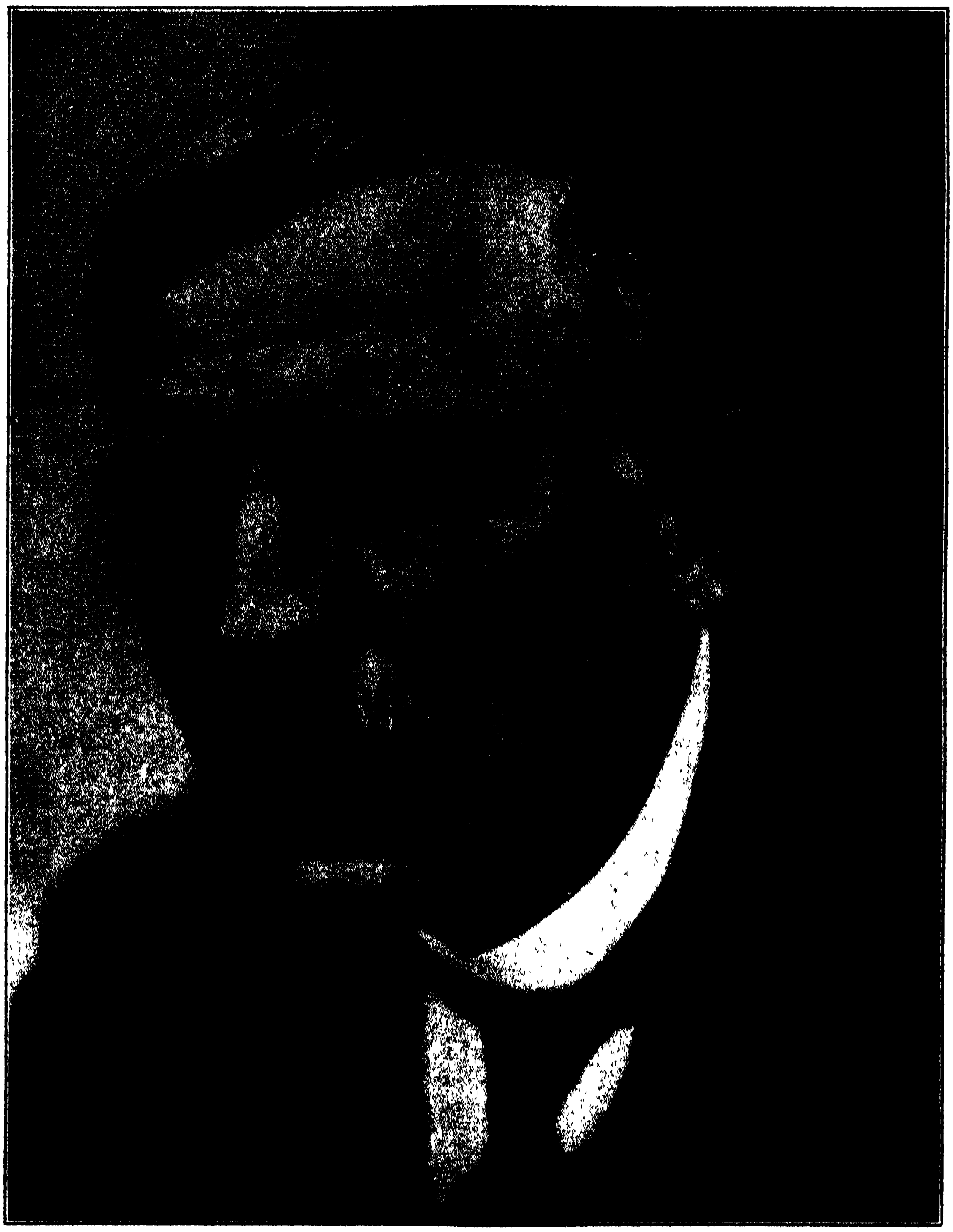


Sir Ernest Rutherford

SIR ERNEST RUTHERFORD was born and reared a New Zealander; he was professor of physics at McGill University in Canada for nine years; and in 1919 he succeeded Sir J. J. Thomson as Director of the Cavendish Physical Laboratory at Cambridge in England. His fame is founded mainly on his basic researches in radioactivity; the new student of that domain of physics may scarce turn a page without encountering his name, linked in many cases with those of Soddy, C. T. R. Wilson, and others who about two decades ago were pioneering in work which has since been seen to be of the utmost significance in physics. His is the discovery, for example, of the alpha rays or alpha particles. Honors too numerous to mention have been heaped upon him--degrees from European and American universities, and coveted medals, including the Franklin Medal of the Franklin Institute in Philadelphia. At present he is President of the Royal Society (properly The Royal Society of London for the Improvement of Natural Knowledge), the highest honor at the disposal of British science.

Great Britain's Foremost Physical Laboratory

IN the April number, on this page, we presented a photograph of Ryerson Laboratory at the University of Chicago, which was there characterized as "America's foremost physical laboratory." Now is shown a picture of a part of Cambridge University in England, including the famous Cavendish Laboratory of Physics (marked "CL" on the picture) which men of science regard as Great Britain's foremost physical laboratory.

Cambridge University as a whole is British headquarters for science, and has been so for centuries. It was here that Newton, profoundest intellect of the ages, performed his classic experiments on light and gravitation; and that Darwin, whose concepts of general evolution have had stronger impact on thought than those of any modern human being, obtained his education. Jeffreys the geophysicist, and Eddington the widely know astrophysicist, are Cambridge professors.

Cavendish Laboratory of Physics was organized by the great physicist Clerk Maxwell.

Just as, in Chicago, the Ryerson Laboratory's achievements have mainly been derived from Michelson's inspired leadership, so those made at Cavendish Laboratory have been the resultant largely of the personality of its former director and leading spirit, Sir J. J. Thomson, discoverer of the electron. Among Thomson's students now risen to eminence in physics are Sir Ernest Rutherford, the present Director of the Laboratory, Sir William Bragg, Charles G. Barkla, C. T. R. Wilson, F. W. Aston, and O. W. Richardson. "This," as Professor Arthur H. Compton, of Ryerson Laboratory, puts it, "is the largest group of Nobel Prize men that can be boasted by any laboratory. Under Sir Ernest Rutherford it continues to carry on with increasing vigor the work which Thomson started. To this laboratory can go the credit for having established the existence of both the electron and the proton, largely through the work of J. J. Thomson and Rutherford."

LOCOMOTIVE PARTS OF STRONG ALUMINUM ALLOYS

Aluminum alloys are now being used on some railroads in place of steel for cross-head assemblies, valve motion parts, main rods, and side rods. Aluminum is used to improve the general balance, to increase the boiler power, and to obtain the required durability

Aluminum and Its 'Hard-Boiled' Alloys

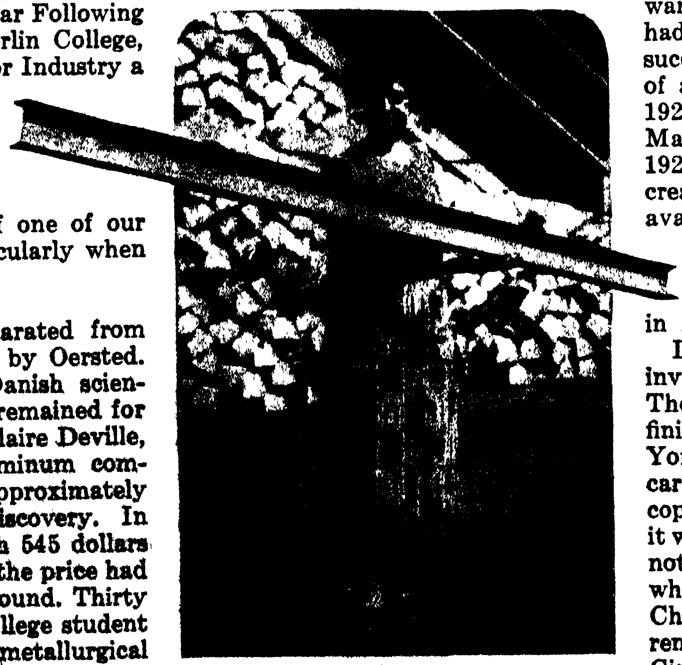
How a Chemical Curiosity Became a 225,000,000-Pound Industry in Forty-Three Years

By ALBERT A. HOPKINS

INVENTIONS are not all made in woodsheds, although it seems rather a logical place for a shop. Given a shop and an inquisitive mind, who knows what may happen? There is, however, one woodshed which Mr. Ford will never have for his Dearborn collection, although he uses large quantities of the product that was born there. Unfortunately, this particular woodshed in Oberlin, Ohio, will also never be marked by a tablet, as it has been removed, but there is one on the house which adjoined it that reads: "In This House Charles Martin Hall Discovered the Electrolytic Process of Making Aluminum, February 23, 1886, the Year Following his Graduation from Oberlin College, Thus Making Available for Industry a Metal Long Known but Little Used." The tablet tersely describes the invention of a process vitally necessary for the commercial production of one of our most useful metals, particularly when alloyed.

ALUMINUM was separated from its chloride in 1825 by Oersted. Wöhler continued the Danish scientist's experiments but it remained for the French chemist, St. Claire Deville, to produce the first aluminum commercially. This was approximately 25 years after Oersted's discovery. In 1852 the metal was worth 545 dollars a pound but in five years the price had dropped to 27 dollars a pound. Thirty years later an Oberlin College student was destined to shake the metallurgical world with an epoch-making discovery and in a short time thereafter aluminum sold for two dollars a pound in 1000-pound lots, a remarkable decrease.

Professor Jewett, of Oberlin College, was lecturing one day and said that if anyone should invent a process by which aluminum could be made on a commercial scale that he would not only be a benefactor to the world but would amass a fortune as well. Charles Hall turned to a classmate and said, "I'm going for that metal." Six months later he came into Professor Jewett's office and said: "Professor, I've got it!" In his hand were little globules of aluminum. Inventor at the age of 23, this young man had carved his way to fame and fortune. A month or two later a French chemist, Heroult, of the same age, made the same discovery independently. On the occasion of the award of the "Perkin Medal" to Hall in 1911, Heroult crossed the Atlantic to congratulate him.



26 1/2 POUNDS

This is not a feather weight, but is certainly light, weighing 3 1/3 pounds a foot

A COMMERCIAL plant was established in Pittsburgh in 1888 by a company called the Pittsburgh Reduction Company, which was the forerunner of the Aluminum Company of America. The first week's production was 100 pounds and it was kept in a safe, as aluminum was still a more or less semi-precious metal. But nobody wanted the product, so the company had to go out and make a market. They succeeded so well that the production of aluminum in the United States in 1928 as given by the American Metal Market was 198,414,000 pounds. In 1929 the production showed an increase but definite figures are not yet available. The average price of virgin aluminum has fallen to 24.3 cents per pound, a far cry from something that had to be kept in a safe and which nobody wanted.

It must not be supposed that Hall's invention did not thrive uncontested. The Cowles Electric Smelting and Refining Company, of Lockport, New York, reduced aluminum oxide with carbon in electric furnaces but only a copper-aluminum alloy was produced; it was a high-temperature reaction, and not electrolytic. The late Judge Taft who was destined to be President and Chief Justice of the Supreme Court, rendered a decision in the United States Circuit Court of Northern Ohio in which he said: "Hall was a pioneer, and is entitled to the advantages which that

ALUMINUM IN BUILDING

The pyramidal roof of the St. Louis, Missouri, Civil Court House was all fabricated from aluminum

fact gives him in the patent law." Other litigation followed, but finally all obstructions were swept away. With the cheap water power at Niagara and elsewhere we are able to obtain vast quantities of aluminum, which is gradually entering more and more into our daily life. It is used in our automobiles, airplanes, buildings, locomotives, and kitchens. It is used so much in everything to do with locomotion that it is interesting to note that its use in bicycles really brought aluminum into prominence. The war helped the aluminum industry; the light weight aluminum alloys dictated their use in aeronautical parts and today aluminum propellers, forged under huge air hammers, are standard on many of the finer planes. The dirigible depends largely upon aluminum alloys and aluminum sheet has even been used in place of a fabric as an outer shell for the ship.

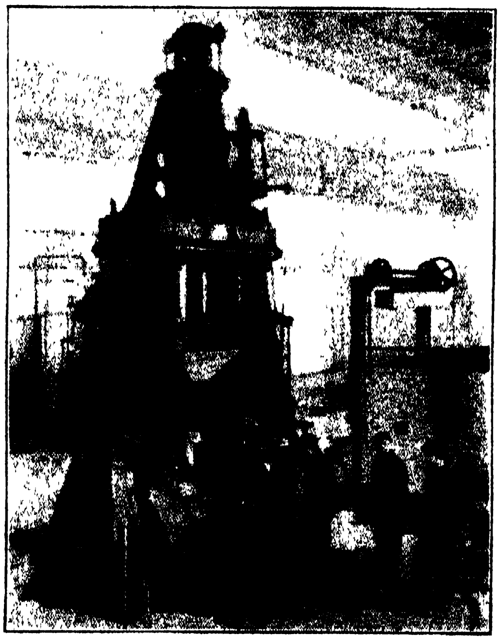
Because of the fact that manufacturers did not have uses for the new metal when it was first made commercially available; the Aluminum Company of America was really forced into designing and making all kinds of things such as bottle caps and seals, foil, and so forth, as well as plates, sheets, bars, castings, forgings and articles fabricated from them. The writer well remembers as a boy seeing the Cowles electric furnaces in "Lower Town" in Lockport, New York. These were under open sheds and it was a puny affair compared with the immense "pot room" at Niagara Falls, where the ingots are now produced.

The aluminum comes to the mills and shops in the form of "pigs" or ingots which weigh about 50 pounds. While large quantities of aluminum are used without alloying for consumption in foil, bottle caps, kitchen utensils, and hundreds of other uses, much of the aluminum of commerce is consumed in the form of alloys. The aluminum and the alloying metal, copper for example, are melted under the most precise pyrometric control, and cast into ingots weighing between one and 30 pounds. The alloys thus made are subsequently remelted and cast into rolling ingots or castings.

IN the case of sheet, tubing, and forgings, the ingots generally weigh between 50 and 300 pounds, but for structural shapes these ingots may weigh upward to 3000 pounds.

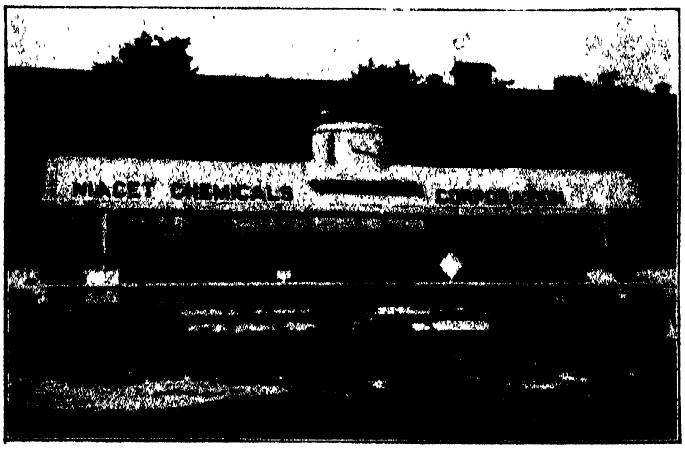
Aluminum and its alloys are cast in a number of ways—by gravity in sand molds; by gravity in accurately made fixed molds (permanent mold process) and by die casting under great pressure. The alloys can be forged under a steam or air hammer just as are iron and steel; airplane propellers are so forged. Remarkable effects are produced by heat-treating aluminum alloys. The end is to secure the best possible distribution of the alloying element and then to fix it. The heat treatment is conducted in electrical furnaces and steam pressure tanks. Aging of alloys, both natural and artificial, also enters the case, but here we are treading on a metallurgical morass so we had better retreat while there is time. Alloys have been developed which can be forged from one piece without reheating. Strong alloys are also made proof against corrosion. Pure, comparatively weak, aluminum is used as a protective coating over strong aluminum alloys. Indeed, the results obtained by heat treatment are so peculiar that it is sometimes called "voodoo" treatment by the scornful. The more you see of the processes of manufacture, the more respect you have for the magnificent laboratories which control it all.

Strong aluminum alloys have been developed to supply engineering materials, having mechanical properties comparable with those of steel, and,



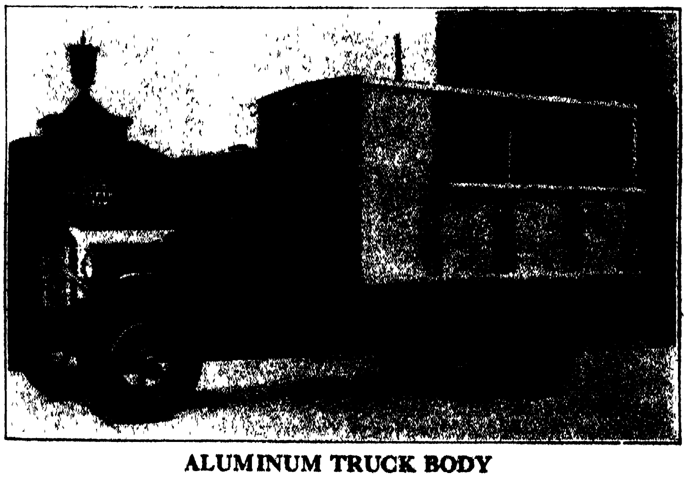
FORGING ALUMINUM

An 18,000-pound hammer is forging an airplane propeller. Some aluminum alloys can be forged



FOR ACETIC ACID

An all-aluminum tank of riveted construction is used for acetic acid, which does not affect aluminum. Capacity is 80,000 pounds



ALUMINUM TRUCK BODY

Every pound of weight that can be saved in the construction of the body of a heavy-duty truck is a pound added to the pay load

ALUMINUM TUBES BY CUPPING

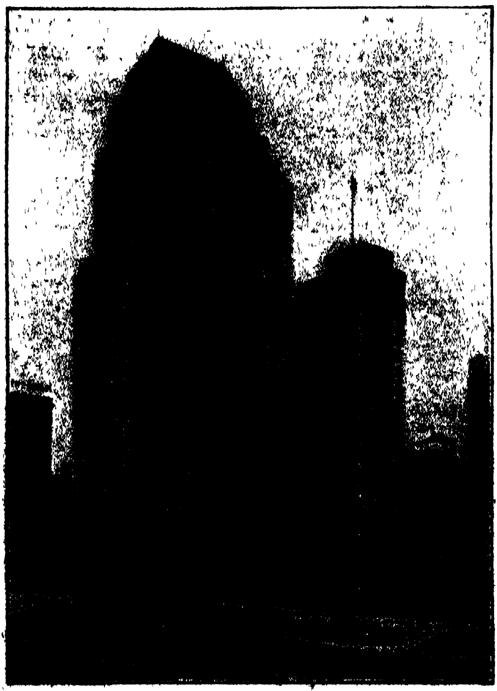
An aluminum sheet is drawn on a cupping press into the form of a tube. Tubes thus produced may be further reduced by drawing

DRAWING TUBES

Round and square aluminum tubing has many uses. Tubes are also produced from the billet by means of an extrusion process

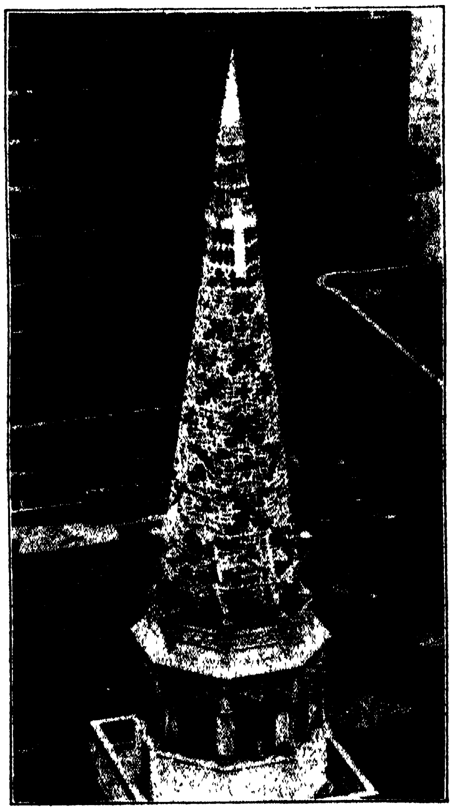
at the same time, retaining the well-known characteristic properties of the parent metal. Briefly summarized, these include low specific gravity, good resistance to corrosion, high thermal and electrical conductivities, and pleasing appearance. Pure aluminum has a tensile strength only about one sixth that of mild steel but "17ST" has a tensile strength of 55,000 to 63,000 pounds per square inch and a yield point of 30,000 to 40,000 pounds per square inch, fully comparable with low-carbon nickel and carbon steels.

These aluminum alloys are of rather recent development, but they have found immediate application in the aircraft and automotive industries, and their use has rapidly spread to other fields. From the truck and the bus, where the light alloys have already proved their worth, it is only a step to the electric and steam railway car, and this step has already been taken. Here the strong aluminum alloys have replaced steel. Such a substitution is not possible on the basis of first cost alone, even when it is considered that the low specific gravity of these alloys results in a very much lower metal requirement for any given part.



ALUMINUM HELPED

Over 100,000 pounds of aluminum sand-cast spandrels were used in the Koppers Building

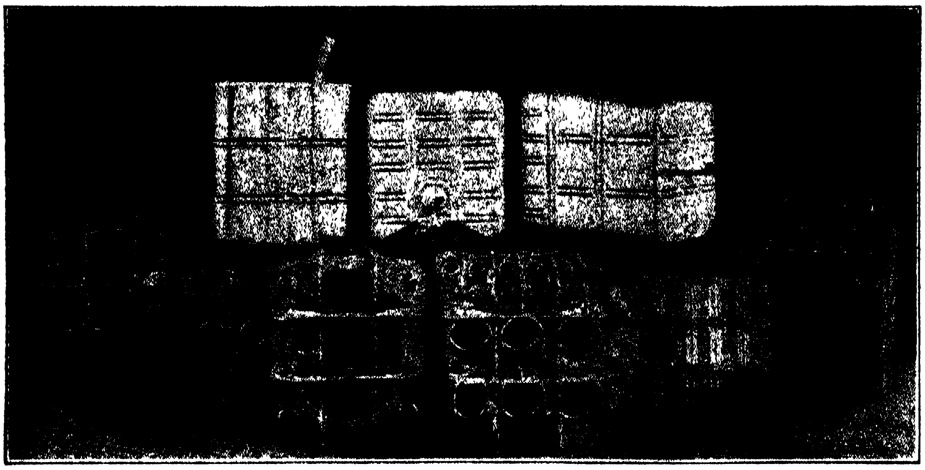


ALUMINUM CHURCH SPIRE

Two hundred and twenty castings were used in the spire in this new church

When, however, the saving in power during the life of the assembly is considered, and also the lower maintenance cost resulting from the decreased inertia and vibrational stresses, as well as the increased resistance to corrosion, the advantage of the aluminum alloys becomes apparent. When, however, the strong aluminum alloys are substituted for other non-ferrous alloys, there is frequently an actual saving in metal cost.

Almost at the birth of the automobile industry aluminum was recognized as an important material of construction and the automobile manufacturer is aluminum's largest customer. Aluminum is ideal for truck bodies in that it increases the pay-load or decreases the dead weight of the truck. Fuel consumption and wear and tear on the chassis are also lessened. Even if an aluminum body costs 600 dollars more, the revenue is increased some 800 dollars a year and the scrapped body can be sold for around 300 dollars. Trolley cars with aluminum bodies are giving excellent service and show the way to increased economies. The Navy's metal-clad dirigible *"ZMC-2"* not only has an aluminum framework but is enclosed in aluminum sheeting. The use of aluminum in airplanes is almost an old story now. Aluminum is ideal for many parts of the radial motors and forged aluminum propellers are largely used. Outboard marine motors afford a fine field for the use of aluminum. In washing machines, vacuum cleaners, and other household appliances aluminum enters the house as well as via the kitchen. Seals for bottles are made at New Kensington, Pennsylvania, by the hundreds of millions and are used on products packed in various places all over the globe. Aluminum foil is largely used in place of tin foil and can be obtained in all the colors of the rainbow. Aluminum tanks make good oil storage containers and aluminum tank cars carry acetic acid safely.



AIRCRAFT TANKS

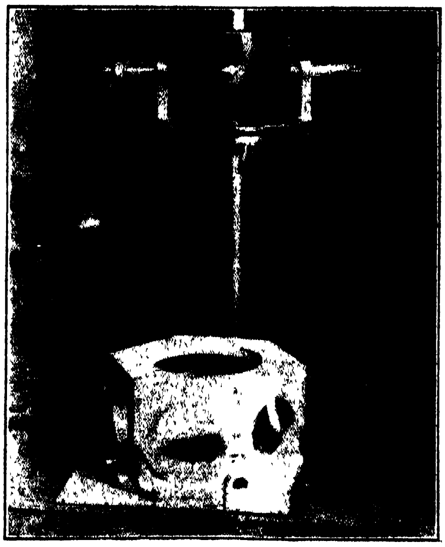
Here we have finished and semi-finished gasoline tanks for aircraft. Lightness is essential in such parts, and for this reason they are fabricated from aluminum sheet. Note the baffles

Aluminum furniture has come into its own. An average aluminum chair weighs only about seven pounds.

Aluminum is very successful in the building field. Over 900 aluminum spandrels were used in the Koppers Building in Pittsburgh, while in the new Chrysler Building in New York the spandrels, copings, and sills are of aluminum. Aluminum shingles and cast aluminum ornaments and crestings are being largely adopted.

Shingles made of aluminum have many points of excellence due to the inherent properties and qualities of the metal itself. They are wind, water, and weather tight. They are unbreakable and non-inflammable. They are frost proof; they cannot crack nor leak, because they are flexible. They are, of course, non-rusting and are light in weight, thus relieving the roof framing timbers of excess weight. These shingles are laid from the top downwards, so no scaffolding is laid over them and they are not injured by being walked on. Sheets of aluminum have been exposed to the ravages of the elements for over 25 years and at the end of that time they show no appreciable deterioration. This is worthy of note, when considering various shingle materials for building.

One of the most striking uses of aluminum for architectural purposes will be found in a church in Pittsburgh in the downtown section, surrounded by lofty office buildings. This church is the German Evangelical Protestant Church which is built in a modification of the French Gothic style. The spire is made up of aluminum castings. There are 221 castings used in this striking edifice which towers 259 feet above the level of the street. The spire is octagonal and is 80 feet in height. It rests on a concrete base 179 feet above the street. The crosses on both sides are also made of aluminum and are illuminated at night. The extreme tip of the spire is a single casting weighing 201 pounds. This spire will never have to be painted and it stands out brightly under Pittsburgh's rather trying climate. Aluminum also caps the Washington monument. The capstone weighs 3300 pounds and is finished off by a small pyramid of aluminum 5.6 inches at its base and 8.9 inches high. It weighed 100 ounces, being the "largest piece of this metal ever cast in any country." This was in 1884; recently a 3800-pound base for a Diesel engine was cast.



LOOKING FOR DEFECTS

X-raying a crankcase. Heat treatment and forgings necessitate such inspection

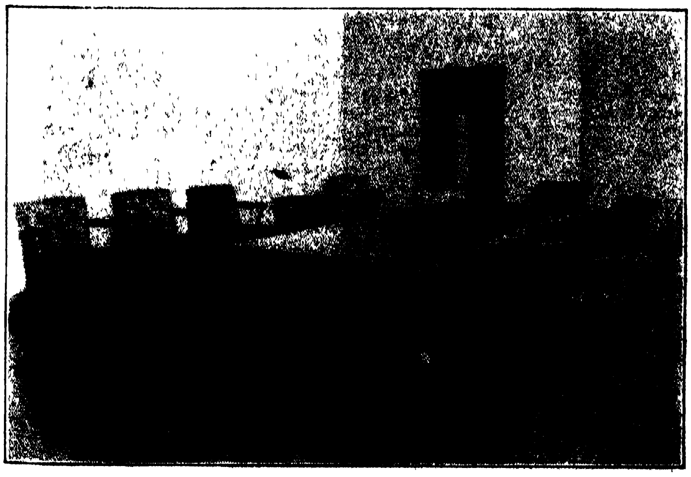
Aluminum paint is used in many industries. The pigment base is "albron," which is made by stamping pure aluminum into small, flat, and very thin *flakes*, which, when mixed with a suitable oil or varnish vehicle form aluminum paint. These tiny flat flakes overlap one another when applied. They arrange themselves layer on layer much like falling leaves. Thus there is formed a metallic sheath that can be readily washed. One coat will completely hide a black surface.

ONE more example of the application of strong aluminum alloys, in this case to locomotives, and we are through. It has been found advantageous to provide reciprocating parts of aluminum alloy. Any weight saving in the reciprocating or rotating parts can be put into boiler capacity without increasing the weight on the drivers. The saving in rail hammer is very great.

So here we must take leave of this very light and versatile metal and its useful "hard-boiled" alloys, to mill out new uses in our machine world.

BOTTLE SEALS

Girls place tin disks in the aluminum capsules as they pass by on a conveyor. A cork liner is dropped in and a groove secures it



ALUMINUM CHAIRS

Here is a director's room entirely equipped with aluminum chairs. Having no dowels they are especially valuable for dining cars

OUR POINT OF VIEW

The Rights of the Governed

PROBABLY no one will dispute the affirmation that the Constitution of the United States was promulgated with the inherent idea that, insofar as it is possible, the people shall have a direct voice in their own government.

As the years have passed, the practical operation of law-making and law enforcement has been more and more delegated to representatives, which though a proper procedure in itself, has resulted, in many cases, in the evolution of a situation where representatives do not always represent the opinions and beliefs of their constituents. This is evident in the agitations for the "referendum and recall"; by the pressure of public opinion which forced the passage of the XVII Amendment, the election of United States Senators by direct popular vote; by direct primary nomination in certain states, and so forth.

Even these reversions to older tradition of self-government have not entirely ameliorated the conditions, for we still find some of our representatives being governed by the opinions of a close coterie who are accessible and whose influence has weight with them, or by a part of their constituency who are most vociferous. It is true that when the situation becomes flagrant, the people will correct it by the removal of such misrepresentation, but in the ordinary run of events a representative can continue to misrepresent the majority of his constituents for long periods before retaliating wrath can be organized to overthrow and punish by elimination.

If popular vote can make, it surely has the same right to unmake. The aphorism that because a law is on the statute books it must remain and be enforced regardless of popular will, is as fallacious as that a man should continue to do something injurious to himself simply because it is a custom or a fad.

Criticism appears in some quarters of the nation-wide poll on the prohibition amendment now being taken by the *Literary Digest*. Yet, fundamentally, what is censurable in any honest effort to learn what the public really wants? Without a doubt this effort is an honest one, and to our mind it is representative, although as to the latter there is a basis for argument.

If the XVIII Amendment was put through as a war-time measure, at a time when we were ready to agree to anything that might help us to victory, and we now wish to reconsider that action in the light of present peace-time prosperity, who can gainsay us such a right?

It's Not the Cost

CRITICISMS of the increased rates for American naturalization papers seem partly justified by statistics. For the July-December, 1929, period as compared with the same period of 1928, the number of first-paper applications fell from 114,469 to 79,346, and second-paper applications fell from 106,028 to 65,887. Under the old rates, first papers cost one dollar and second papers four dollars; under the new, five and ten dollars respectively.

Unregenerate Criminals

IN a letter to *The New York Times*, Ranulph Kingsley, of New York, declares that we have become too good-natured and easy-going in our dealings with criminals. He believes that "Even if we have to pock-mark the state with prisons, we should put every confirmed criminal in one and keep him there." Mr. Kingsley states that since holding up the United States mail with gunplay was made punishable by life imprisonment some years ago, that kind of crime has noticeably decreased. He would have the states adopt laws as stringent as this federal law; and, further, he believes it inadvisable to take pistols away from honest people yet very necessary to teach the criminal that when he goes out at night with a pistol, "he goes to his own swift and inevitable imprisonment for life."

We heartily agree with Mr. Kingsley. Under the present lax system, too many politicians are working hand-in-glove with the underworld, too many murderers are brought in simply for questioning and then are let go with a smirk on their faces, too many foreign-born are conducting rackets that terrorize honest citizens. It is all very well to philosophize about the exploitation of human beings that leads them to become criminals, to prattle of reforming them, to pity them for their supposed lack of advantages, but that is not enough. All this is the fault of the system; therefore the system should be changed. Many years will elapse, however, before we have made a start in this direction and, in the meantime, confirmed criminals, with minds warped irreparably, continue their depredations on society. What we need right now is a Mussolini to round up our "Mafia" and a few jurors who are not too chicken-hearted to send the criminal up long enough to pay fully for his crime.

The drop in the number of applications has been laid to the increased cost, and the principal criticism of this increase seems to be that the tendency will be "to perpetuate an alien group." It is contended that the alien most often belongs to the low-income class and finds it exceedingly difficult to spare the money for naturalization papers while maintaining himself and his family, building a home, and educating his children. To some extent, then, the criticisms are justified, but—

The alien, as a rule, comes to this country because of his intolerable poverty in some other. If he belongs to this class, citizenship should be cheap at any price. There are some, of course, for whom the expenditure of the few extra dollars would work a hardship but the amount is so small even under the new rates that they can and will manage somehow if they seriously desire to share the benefits and prestige of American citizenship. As for those who can afford the price and will not because of indifference or lack of appreciation of what it means to them, and those who cannot because their earning power is too low, we do not want them. They are not the stuff of which good American citizens are made.

Questionable Success in London

A THREE-POWER Pact has been agreed upon by Great Britain, Japan, and the United States. For the present the differences between France and Italy have proved irreconcilable; but it is the intention of Great Britain, France, and Italy to continue negotiations in the hope of developing a formula that will enable the two Mediterranean powers to join the pact. We have a direct interest in the solution of the problem between Italy and France, because it may affect the number of cruisers considered necessary by Great Britain.

If the tentative agreement is carried out, the fleets of Great Britain, Japan, and the United States would be as follows:

	United States	Great Britain	Japan
Capital Ships	15	15	9
Cruisers (tons)	323,500	339,600	208,900
8" Cruisers	18	15	12
6" Cruisers	19 or 20	34 or 35	12 or 13
Destroyers (tons)	150,000	150,000	105,000
Submarines (tons)	52,000	52,000	52,000

(*Please turn to page* 485)

Super Magnetic Fields

Some Remarkable Experiments in England—"The Most Interesting in the World"—Promise New Revelations in Physics

By J. G. CROWTHER*

THE behavior of the compass needle is described by saying that a magnetic field of force exists on the earth's surface. The magnetic force turns the needle to the north. Clearly this field of force must have a definite strength at any particular place; it must be at least strong enough to deflect the compass needle. The strength of the earth's magnetic field is in fact about one half of the unit used for measuring such fields, that is, half a gauss. It is known that the sun has a surface field of about 50 gausses, and in sun-spots the field may rise to 5000 gausses. Very strong electro-magnets can generate fields of upwards of 100,000 gausses, though 30,000 or 40,000 is about their usual manageable limit.

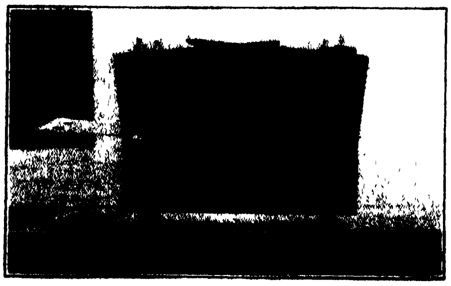
One wonders what will happen in more intense magnetic fields. Superficially, it looks quite easy to discover. You take a bar of iron and wind copper wire around it. You run current through the wire. This produces a magnetic field within the coil and in the iron. The iron concentrates the field around its ends, called the pole-pieces. Put more current through the coil, and the field in the interior becomes stronger.

But this phenomenon occurs only up to a certain point. Iron has only a limited appetite for magnetic fields; it can not absorb them beyond a certain strength. So very strong fields must be made without the assistance of concentrating iron poles. This means that still higher currents must be put through the coil, since the iron will not be there to assist in the concentration.

BUT copper wires heat when currents are passed through them. When the currents are above a certain volume, the wire is heated above its melting point. Thus, seemingly, there is a limit beyond which the field inside a copper wire coil can not be raised—the limit determined by the melting point of the coil.

Dr. Kapitza, working at the Cavendish Laboratory at Cambridge University, has shown how this limitation can be evaded. Suppose an enormous current is sent through the coil, but only for a tiny fraction of a second. Even the most powerful current takes some time to heat up the wire. May it not be possible to get the enormous current through the coil and cut it off again before it has had time to melt the copper wire? This is Dr. Kapitza's method. He sends the current through the coil for not more than 1/100th of a second.

Although this sounds simple, the execution of the method bristles with difficulties. Obviously, everything has to be done in less than 1/100th of a second. Even after the apparatus itself is successfully designed, all the experiments have to be carried out and measurements made within periods of 1/100th of a second. The fields exist for a period of 1/100th of a second. If their duration has to be accurately defined, they must be started and stopped almost instantaneously. Dr. Kapitza's switch for making and breaking the circuit can operate in 1/10,000th of a second.



AN EXPLODED COIL

The magnetic field, 600,000 times as strong as the earth's, is produced at the center

The powerful currents are obtained by short-circuiting a dynamo. The machine Dr. Kapitza uses is of a special design. It is wound so that the current alternates its direction during a revolution, that is, it has a single phase winding. At the beginning of a revolution the current is zero. It rises to a maximum at the quarter revolution and then declines to zero again at the half revolution. The current then changes its direction, rising to a maximum in the new direction at the three quarter revolution, and declining to zero again at the full turn. With such a machine, the current will be zero at the beginning, the middle and the end of a revolution. The volume of the current at the maxima will depend on the size of the machine. In Dr. Kapitza's machine the maxima are about 30,000 amperes. By special winding the maxima can be reduced but spread out a little. In this way, he obtains a steady 30,000 amperes for 1/100th of a second, instead of, say, 72,000 amperes for a far shorter fraction of a second.

We now come to one of the many highly ingenious features of this machine. Dr. Kapitza has his source of 30,000-ampere current; how can he tap it?

We all know that when a current is broken, sparks occur; for instance, when a street car trolley jumps off the wire. Will we not get a tremendous spark if we try to break a current of 30,000 amperes? And will not a big spark at each end of the 1/100th of a second period rather blur the definition of the interval? We can avoid all that, says Dr. Kapitza, by seeing that the current is tapped from the machine when it is at one of its zeros.

So the coil for producing the magnetic field is switched on to the dynamo in 1/10,000th of a second when it is producing zero current. As there are limits to mechanical accuracy, the current may not be quite zero, but perhaps a mere 3000 amperes. So the switch must be capable anyway of breaking a current of a few thousand amperes in 1/10,000th of a second. That is why it has to be so large and complicated. Dr. Kapitza considers that the switch was the hardest to design of all the parts of his apparatus.

THE coil has now been switched into the current when the current was comparatively feeble. In a small fraction of a second it rises to 30,000 amperes and remains at that strength for the next 100th of a second. All the experimenting has to be done in this short interval.

For the small fraction of a second when it is short-circuited, the dynamo develops about 50,000 horsepower, and the energy discharged into the coil is about equal to that discharged when a field gun is fired.

The machine was made to Dr. Kapitza's design, in consultation with Professor Miles Walker, of the College of Technology at Manchester, by Metropolitan Vickers at Old Trafford, in England.

The magnetic coil for producing the magnetic field consists of layers of square copper wire, or copper-cadmium alloy. When a current is sent through the wire the opposite sides of the coil repel each other. If the current is small the repulsion is not great but if the current is large the force on the coil tending to make it expand can amount to several tons per square inch of copper.

In his earlier designs, Dr. Kapitza

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*See "Among Our Contributors," page 421.

found that the metal of the coil spread like putty under these repulsive forces. But it is possible to design the coil so that these forces cancel out, except directly outward. So this was done, and a strong steel strap was clamped around the coil to bear the resultant outward thrust. By using copper-cadmium alloy, the coil itself can be made four times as strong as when copper is used, and yet retain 90 percent of the conductivity of copper.

Then a worse snag arose. The repulsive forces tending to make the coil expand made the coil unwind itself a little. Its ends were torn away from their terminals. Coil after coil burst in this way, and the experimenter had the unnerving experience of seeing his experiments failing after all the labor and expense on the dynamo and other apparatus.

After some months of disappointment, the experimenter devised a solution of the bursting coil trouble, and it was possible to proceed with these epic experiments. He designed coils which "breathed," that is, expanded automatically. The central winding in the coil was made out of a piece of copper-cadmium tubing with a helical saw cut. A ring was made to slide around this tube, and then the end of the wire was brazed to the ring. When the coil expanded, the wire just slid the ring around the tube. After being used once, the coil settled into a permanent position cramped against the outer steel strap and the trouble was overcome.

Another difficulty was caused by earthquakes. When a dynamo about to produce 50,000 horsepower is short circuited, it suffers a severe shock which it communicates to its foundations. A small earthquake travels through the laboratory at the rate of about two miles a second. Measuring apparatus, spectrographs, and so on, are thrown out of adjustment. Now these magnetic field experiments last one 1/100th of a second. So, if the coil is placed some distance away from the dynamo, the whole experiment will be over before the earthquake shock has had time to reach the measuring instruments, and so Dr. Kapitza has arranged it. All the photographs and observations are taken before the shock arrives, even though it is traveling at two miles a second.

The unleashing of energy at the rate of 50,000 horsepower for a fraction of a second, has been calculated to produce an exceedingly high momentary temperature inside the coil, possibly the highest temperature the earth has known since it condensed out of solar material. This calculation, and Professor Rutherford's disintegration of atoms at Cambridge, prompted Professor Eddington to remark humorously that, though the interior of a star may be at a temperature of millions of degrees, centigrade, it is quite a mild place compared with the Cavendish Laboratory.

Dr. Kapitza has already made two discoveries of great interest, besides extending magnetic field technique ten times beyond its previous limit. The late Kamerlingh Onnes, the Dutch scientist, discovered that when certain metals were reduced to a very low temperature their electrical resistance decreased almost to zero. Other metals decreased steadily until a low temperature was reached, after which there was a sudden drop in resistance. Still other metals were always left with a certain residual amount.

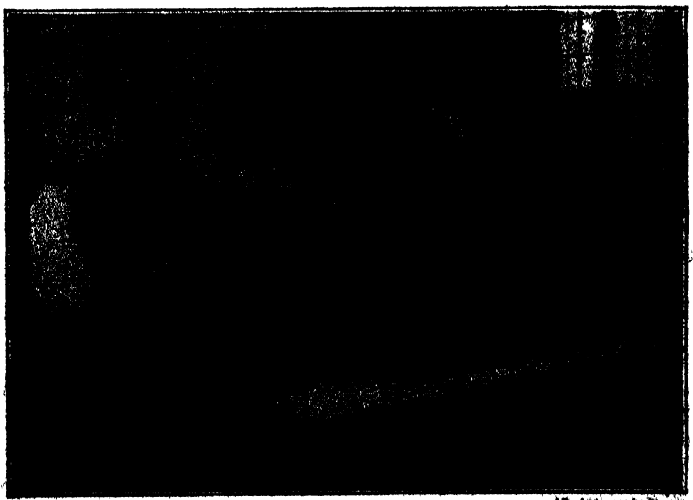
NOW the resistance of metals increases in strong magnetic fields. With the range of field strength at his command, Dr. Kapitza has shown that the residual resistance is due to internal disturbances in the metals. If the temperature could be lowered sufficiently, these disturbances would disappear. Thus he has shown that the same laws of variation of resistance control all metals under undisturbed conditions; the exceptions are due only to disturbances which can be removed by adequate technique. A jumble of varied data has been reduced to order.

His next remarkable result was published recently. He has discovered the phenomenon of atomic magnetostriction; that is, the stretching in a magnetic field of the bonds between atoms. It has long been known that metal rods change their length when placed in magnetic fields. This old phenomenon is completely describable in terms of the elasticity of the metal and what is known as its magnetic susceptibility. It is due to slipping or rearrangement of the polar crystal units of which the rod is built up.

Kapitza's phenomenon is quite different. The crystal units themselves are distorted under the enormous stresses of his intense magnetic fields. He finds that the strong fields tend to increase the strength of strong short bonds between close atoms, and to weaken the weaker bonds between atoms farther apart. Thus Kapitza has started a completely new line of attack on the nature of certain of the forces acting between the atoms of magnetic solids.

The greatest achievement in science consists in the invention of new methods. Once a new method is devised, it can be applied to hosts of objects, and must almost necessarily reveal new facts, many of which must be important. Dr. Kapitza has devised a new method. It is not at all unlikely that the next great advance will be the outcome of applications of this method.

For many years the study of magnetism has been in a jumble. Straightening the jumble will almost certainly reveal an atomic design of the profoundest significance. It looks as if Dr. Kapitza is in a fair way to do this straightening. At the moment, no one in the world is making more interesting experiments in physics.



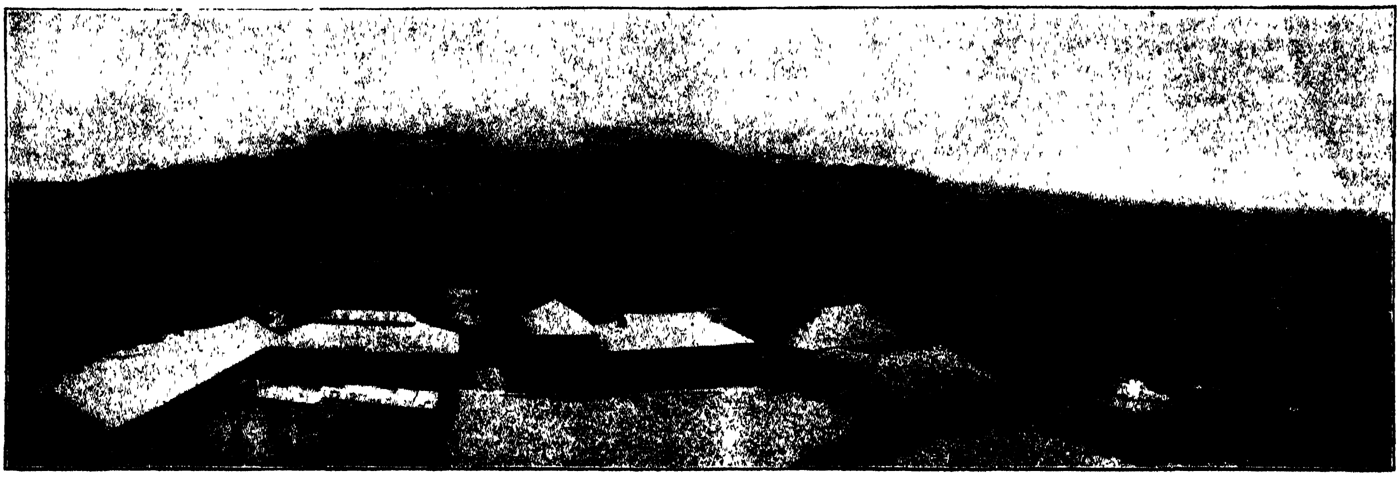
All photographs by courtesy of P. Kapitza, F.R.S.

MACHINERY FOR PRODUCING THE FIELDS

The dynamo gives electrical energy at the rate of 50,000 horsepower during a period of about 1/100th of a second. It has a special single phase winding, which is described in the text

THE SWITCH, AN UNUSUAL PIECE OF DESIGN

This must be capable of cutting off a current of about 5000 amperes in 1/10,000th of a second; the maximum is 30,000 amperes, which flows through the circuit for 1/100th of a second



A COCONUT PLANTATION IN THE PHILIPPINE ISLANDS

Piled against the side of the thatched hut to the right of the center of this photograph are thousands of coconuts. In the center foreground is a large area covered with coconuts that have been broken open and exposed to the sun to dry. The resulting dried meat is called copra

From Coco Palms to Coconut Oil

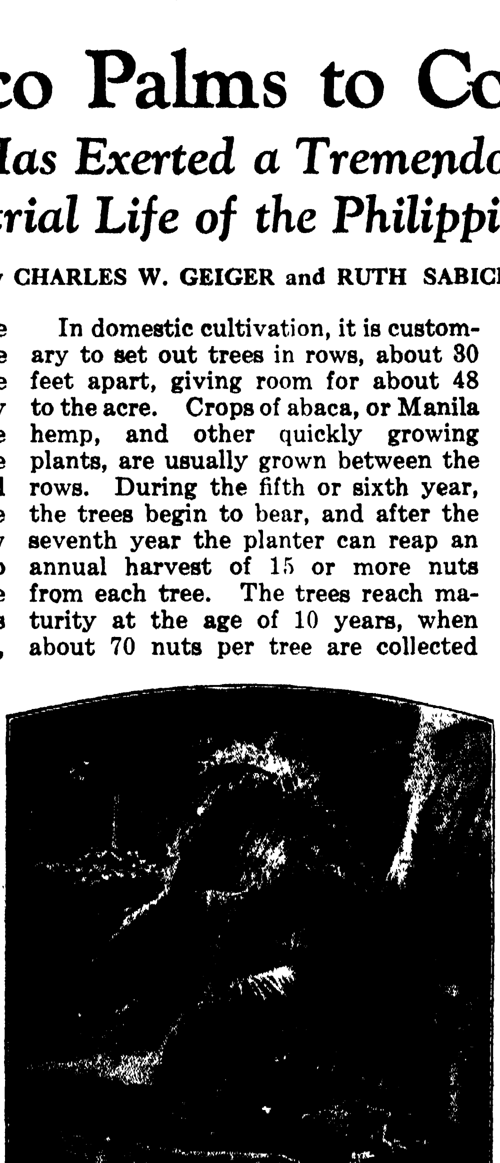
The Coconut Has Exerted a Tremendous Influence in the Industrial Life of the Philippine Islands

By CHARLES W. GEIGER and RUTH SABICHI

COPRA, the dried meat of the coconut, has figured in the romance of world trade since the days of Magellan. The story of the coconut is the story of the economic progress of the Philippine Islands, to which it has contributed more than any other product, with the possible exception of hemp. Few plants, if any, are as serviceable to primitive man as is the coconut. The nut meat is eaten as food; the oil is useful in making edible fats and soap, and is also used for illumination; the tree roots provide a dye, and the trunks, building material; the leaves are employed for thatching roofs; the midrib of the leaf is used for making baskets, brooms, and brushes; the fiber from the nut husk is woven into ropes and mats; and the nut shells, in addition to providing fuel, are shaped into cups, ladles, spoons, and other utensils.

UNDER primitive conditions, the production of coconuts, copra, and coconut oil was confined to the groves of wild palms that skirted tropical shores. These wild or uncultivated trees still constitute a considerable source of supply when the market price is sufficiently attractive to the natives. The coco palm, however, is now cultivated like any other staple agricultural product. Large plantations are to be found throughout the tropics, for supplying the international trade in copra and coconut oil.

In domestic cultivation, it is customary to set out trees in rows, about 30 feet apart, giving room for about 48 to the acre. Crops of abaca, or Manila hemp, and other quickly growing plants, are usually grown between the rows. During the fifth or sixth year, the trees begin to bear, and after the seventh year the planter can reap an annual harvest of 15 or more nuts from each tree. The trees reach maturity at the age of 10 years, when about 70 nuts per tree are collected annually. In rare instances, as many as 500 nuts have been harvested in a year from a single tree, and trees have been known to continue to produce after reaching an age of 150 years.



IN THE JUNGLE

At the right is a coco palm. In the left background is a primitive cart for hauling nuts

The natives pick or shake the nuts from the trees and crack them open with a machete. The broken nut meats are then placed in the sun to dry. Sometimes the broken pieces are placed on drying racks under which coconut husks are burned to speed the drying process. The resulting smoke-colored copra is called "smoke-dried" to distinguish it from that which has been sun-dried. The fire-drying method is used in regions where excessive rain makes natural drying impossible. Mechanical driers are employed on some of the larger plantations, but the practice has not become prevalent.

MATURE nuts yield copra of the best quality, but it is customary for the natives to harvest the nuts before they are ripe and depend upon a month's curing on the ground. Copra made from immature "meat" has a tendency to re-absorb moisture after drying, as well as to become moldy and sour, but dry-curing before removing the husk that surrounds the shell overcomes this objectionable tendency.

In some parts of the islands, where sunshine during the harvesting season is very uncertain, the copra is dried by the use of a *tapajan*. This device is a bamboo

REMOVING HUSKS

Before the nuts are broken and meats extracted, the thick, fibrous, outside husk must be removed

grate, about 20 feet square, under which a rough earthen oven has been prepared. Over the grate, a roof or watershed is erected, composed of coconut fronds. The nuts are husked and the shells split, and the broken coconuts are placed on the bamboo grate. A fire is built under the grate, and the meat shrinks from the shell as it dries. The shells, when removed from the meats, are used as additional fuel for the fire. The total drying time by this method is from five to 12 hours.

THE natives have various ways of disposing of their crop. In some districts, they sell their copra direct to the dealers at trading stations operated by the exporters. Chinese merchants in the small towns also acquire much of the local copra stocks, usually giving merchandise in exchange. The merchant, in turn, settles his accounts in the form of copra shipments. The coconuts are frequently made into "rafts," and are floated down the rivers to market.

Some years ago it was the practice to ship almost all of the copra overseas for crushing and conversion into coconut oil, but a few mills have been established in the Philippines, in India, and in the Dutch East Indies. These local oil mills have become important factors in the copra market, exerting a balancing influence on the market price of copra and oil. However, the proximity of raw material, and the cheap native labor available for operation of the mills is offset by lower power costs, more efficient labor and machinery, and more convenient marketing conditions in the United States.

Copra first became an important item in world commerce in 1886, although a French sailing vessel had carried a load of coconuts to Marseilles as early as 1750. Marseilles soon became a manufacturing center for copra products, and is still one of the most important copra importing ports of the world. It was in France that the first butter substitute, consisting of coconut oil and peanut oil, was produced.

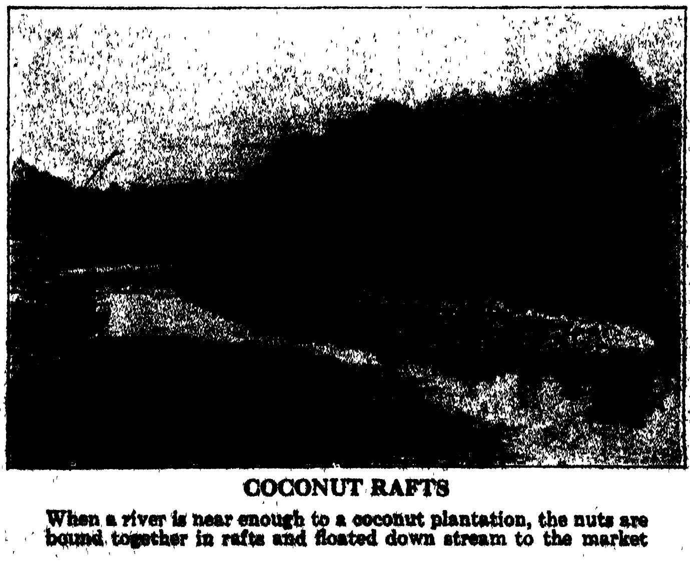
Traders, operating sailing vessels in the South Seas about the year 1890, brought copra and other native products to the United States. Coconut oil mills were established at San Francisco and Berkeley. The phenomenal growth of the copra industry in the United States is shown by the fact that imports in 1920 amounted to 218,521,916 pounds, of which only 7 percent came from the Philippine Islands. By 1927, our copra imports had increased to 450,994,519 pounds, of which 72 percent came from the Philippines. Of the 238,471 tons of copra exported in 1928 from the Philippines, 181,111 tons came to the United States, and 57,360 tons to Europe. About two thirds of the American copra imports were consigned to the major Pacific Coast ports — San Francisco, Los Angeles, Portland, and Seattle.

Originally coconut oil extracted from copra at the source was shipped to San Francisco and other ports in five-gallon cases, barrels, and drums.

THEN a system was perfected whereby the oil was shipped in tank steamers and in deep tanks on passenger and cargo vessels operating between America and the Orient. This practice immediately revolutionized the transportation situation; for years the great ocean steamers had been carrying petroleum from this country to the Orient and returning in ballast, until someone thought out a practical scheme of carrying the coconut oil on the return voyage. A number of tank steamers are now engaged in transporting petroleum from Pacific Coast points to the Orient, returning with a capacity cargo of coconut oil in the same tanks.

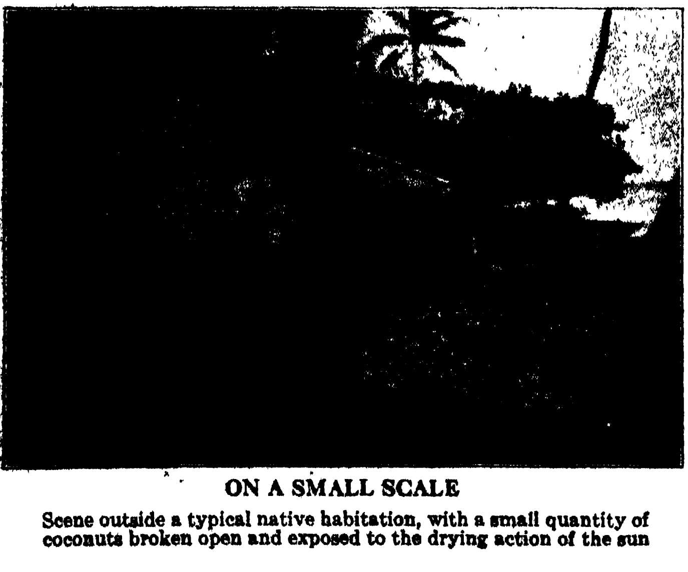
Of course it was necessary to devise a very effective system of cleaning the tanks of the ships before filling them with edible oil. After the petroleum cargo has been removed, a charge of live steam is forced into the tanks. This is continued for a period of 12 to 24 hours. After pumping out the bilges, and waiting a sufficient length of time for the interiors to cool, men are sent down into the tanks to clean them as thoroughly as possible. Later, upon arrival at the port where the coconut oil is to be taken on, the tanks are given a final cleaning.

A fleet of specially designed coconut oil barges, with two large pumps, transfer the oil from the copra crushing plants in Manila to the oil tankers or



COCONUT RAFTS

When a river is near enough to a coconut plantation, the nuts are bound together in rafts and floated down stream to the market

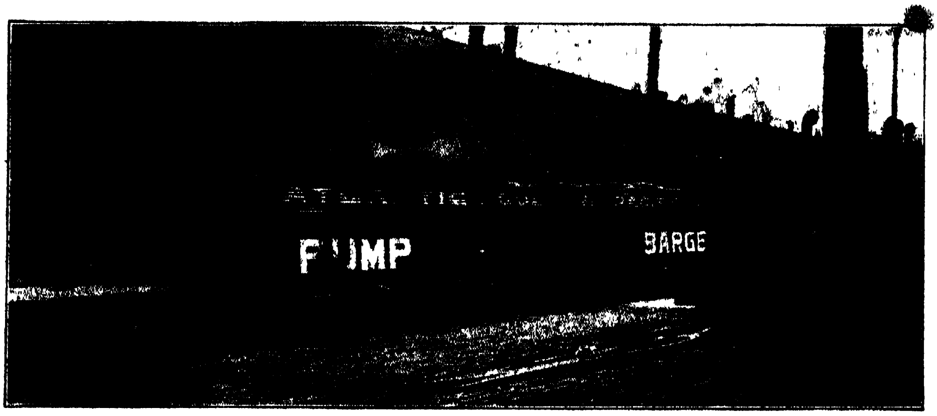


ON A SMALL SCALE

Scene outside a typical native habitation, with a small quantity of coconuts broken open and exposed to the drying action of the sun

OIL TRANSPORTATION

Above: Specially designed coconut-oil barges are used to transfer the oil from the crushing plants to huge tankers. *Right:* A pump barge alongside a tanker. The machinery pumps the oil from the barges to the tanks on the ocean steamer



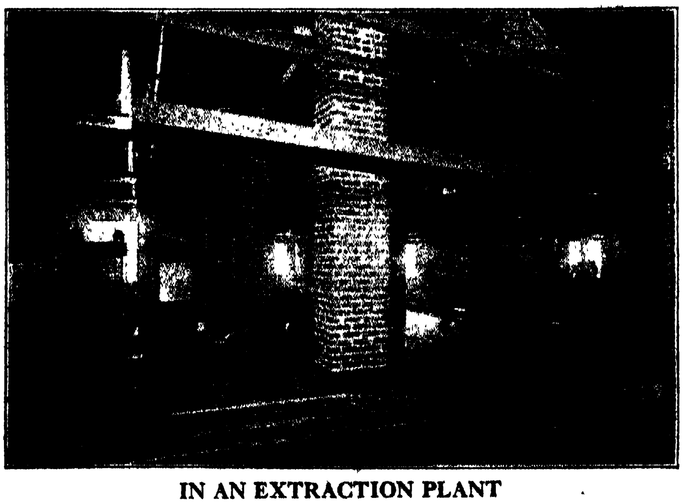
passenger vessels equipped for transporting oil. Each barge has a capacity of 250 tons of coconut oil. Pump barges are equipped with two duplex pumps, each of which can pump 100 tons an hour. There are always a number of loaded barges on hand, so that there will be no delay in transferring the hose when one barge has been emptied. A loaded barge is pushed into place while an empty one is being removed, and the pumps seldom stop running until the tanker has been filled to capacity or the supply of coconut oil available at the time has been exhausted.

The most important factor in handling coconut oil is temperature, for in order to keep the oil in a liquid state, the temperature must be more than 70 degrees, Fahrenheit. Under cooler conditions, it hardens into a dense material resembling butter or lard. Consequently it is necessary to provide heating pipes in the tanks of the steamers, in storage tanks, and in the tank cars used for distributing the oil in the United States. In many cases, the delivery pipes or hoses have a small heating tube running down the center, carrying steam or hot water. Compressed air is sometimes used to force the oil out of tankers and the loading pipe, in order to expedite the transferring operation.

When the copra is not to be pressed at its source, it is transported in much the same way as other bulky materials are handled. One of the most familiar sights in San Francisco Bay is the process of transferring copra from the holds of ocean-going ships to the dock. By means of large metal tubs operated by the ship's tackle, overhead hoppers on the dock are filled. Dump wagons and trucks back up under the hoppers, where they are loaded and then proceed to the warehouse or crushing plant. Copra is also transferred directly from the ship's hold to railway cars. On the Oakland waterfront there are several pneumatic boat unloaders which "suck" the copra from the hold, loading it into a railroad car or warehouse.

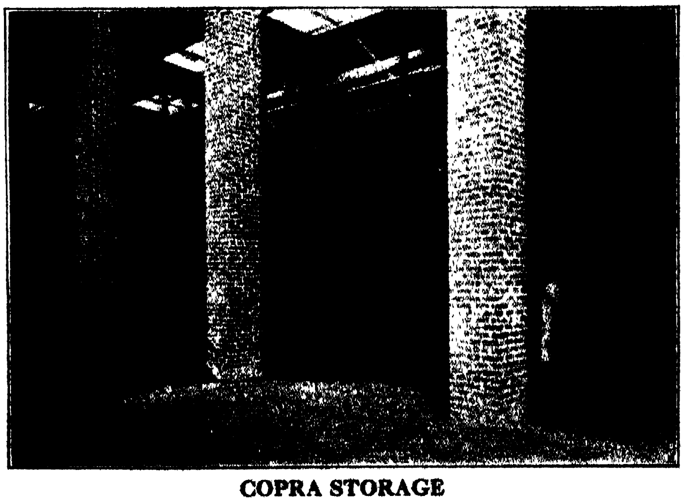
In making coconut oil, the copra is first put through expellers which force out about 25 percent of the oil content. The residue is then ground into meal, and the remaining oil content is squeezed out by hydraulic presses. Most of the oil is then filtered, and used for the manufacture of soap, shaving cream, shampoo solutions, and a long list of cosmetics. Some of the coconut oil is used for edible products, and must be refined several times to remove free fatty acids, color, and odor.

Besides being used in making margarine, the oil is employed in manufacturing thin sugar wafers, cookies, candies, and for shortening in cakes and pies. About 63 percent of the copra is converted into coconut oil, and the remaining 37 percent is used as coconut meal, which has high food value and is used as a feed for stock and poultry. About three fifths of the coconut oil consumed in this country is used in the soap industry; one fifth is used in the production of margarine, and practically all of the remainder is consumed in the manufacture of candy and biscuits.



IN AN EXTRACTION PLANT

This copra crushing plant is located in Berkeley, California. In the left background are three hydraulic presses for pressing oil



COPRA STORAGE

Part of the dried copra is shipped direct to this country, where the extraction of oil takes place. This pile of copra awaits pressing

Birds of a Bleak Arctic Island

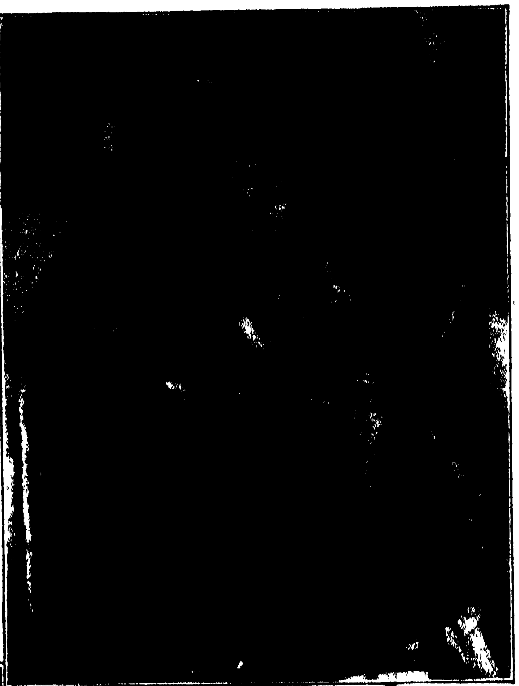
A Bit of the Far North Is Borrowed for a Museum Habitat Group

IN Bering Strait, a few miles south of the Arctic Circle, lie two granite islands. The larger, Big Diomede, seven miles long, is Russian; Little Diomede, much smaller, is American. Here where the East and the West are but little over two miles apart, the East is to the West, and the West is to the East! The International Date Line, here a line of convenience, swings east of the 180th meridian and passes between the two islands. The days are born on Big Diomede, follow the sun around the earth and end 48 hours later on Little Diomede.

AT Little Diomede was collected the material for the Bering Strait Bird Group which completes the series of habitat groups of North American Birds at the American Museum of Natural History, under direction of Dr. Frank M. Chapman. Mr. Francis L. Jacques, Assistant in Preparation, says in *Natural History* that his problem was to suggest to the museum visitor, through sight alone, some sense of the flying gray clouds, the wind-whipped sea, the cool salt air, the towering cliffs with their teeming bird life, and the savage loneliness of the scene. The group space is 20 feet in width, 7 feet from front to back, and 12 feet high.

The birds having been collected, and the skins properly prepared, the artist faced the problem of how to use the material obtained. The first step in making a museum group is the construction of a scale model. The model made for this group was about 30 inches long, or one and one half inches to the foot. About 65 mounted birds are used in the group. Each bird is mounted to fill a certain place according to the scale model.

The American Museum has a large staff of preparators and artists under the direction of Mr. James L. Clark, and a number of habitat groups are now being prepared, each with problems of its own as difficult, or more so, than those of the group described. Museum standards are being raised so that we may expect even more perfect groups.



BEHIND THE SCENES

Trained taxidermists mounting the birds in the Department of Preparation and making the plaster rocks which will support them. Realism is the result of careful attention

ARCTIC BIRD GROUP

Here the artist has transferred his impressions of a remote arctic island through the medium of paint, plaster, and mounted birds

SEA, ROCKS, AND BIRDS

The Bering Strait bird group shows almost inaccessible places where the birds gather. There are 65 mounted birds in the group

Fragmentary Molecules of the Sun

On the Sun Most of the Elements Are in Isolated Atoms, Because of the Heat. Unfamiliar Compounds Are Being Discovered

By HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

NOT long since (February and March) it was told how an analysis had been made of the sun's atmosphere, giving not only a list of the elements present there but the approximate quantities in which they appear. The upshot of this work was that the solar atmosphere consists mainly of hydrogen mixed with a much smaller proportion of the other prominent gases (perhaps one part in 12) and a still smaller quantity of metallic vapors.

The question then arises, are the other bodies known to astronomy of similar composition? How about the stars—and the earth and the other planets?

The answer comes easily for the stars, far off as they are. Thousands of them have spectra almost exactly like the sun's, and therefore must have atmospheres of very similar composition. For the rest, which are hotter or cooler than the sun, the spectra often appear at first sight very different, but when allowance is made for the different manner in which atoms are set up in the business of absorbing light or put out of business at different temperatures it is found that the stars too do not differ greatly in composition. Indeed, Miss Payne, whose work at Harvard has given us most of our information in this matter, concludes that the stars are "remarkably similar in composition."

FOR the earth the resemblance is apparently much less close. We know with certainty only the composition of the outer crust of our planet down to a depth of perhaps a few dozen miles, though the general nature of the denser material in the deeper interior is fairly well assured. This is composed mainly of *rocks*—compounds of the metals with silicon and oxygen. Hydrogen, instead of being predominant, is present only in a small percentage, mainly in the ocean water.

It is important, however, to notice that the relative proportions of the various metals in the terrestrial rocks are not very different from those of the same substances in the sun. Just those metals which are the main constituents of the rocks—aluminum, iron, calcium, sodium, potassium and magnesium—are the most abundant in the solar atmosphere; and silicon and oxygen, still more abundant in the rocks, are also present in great quantities in the sun. The detailed proportions are different; there are more aluminum and silicon on earth and less magnesium. But it is probable that if we could get at the dense deep-lying rocks which form the main bulk of the earth the discrepancy would be smaller.

The earth, then, is very similar in composition to what we would get out of the sun's outer layers if we let a great mass of them cool down and preserved the portion that liquefied or solidified, throwing away about all the excess of uncondensed gases. But this is exactly what might be expected to have happened if the earth was produced by the ejection of incandescent matter from the sun—as all present theories of its origin assume. Hydrogen would escape most easily of all and it is no wonder that there is relatively little of it left on earth.

FOR the other planets we have no chemical data to go on, but only general information about density and the like. The smaller bodies, Venus, Mars, Mercury, and the moon, are probably much like the earth in composition, for similar reasons. The great planets, from Jupiter to Neptune, are so much less dense that it is certain that they contain a much greater proportion of substances of low density than does the earth. Chamberlin and Moulton years ago suggested that this indicated that these larger masses had retained a greater proportion of the light constituents which were originally present in the matter ejected from the sun, and this view is now generally accepted.

In all these respects, then, the composition of the sun, the stars, and the planets appears to be very much the same. But some exceptions are still to be found. There are several important elements and many less familiar ones, the lines of which do not appear at all in the solar spectrum. We know precisely where to look for them, and they are not there. Among the list of missing we find fluorine, phosphorus, and chlorine, which are all present in abundance on the earth; as well as less abundant but familiar ones like neon, argon, bromine, and iodine. Are these substances really absent from the sun?

Modern spectroscopy gives a definite answer. The lines which these substances give in the laboratory (within the range of the spectrum which we can get at in the sun) are all produced and absorbed only by very highly excited atoms heavily loaded with internal energy. Even at the high temperature of the sun only an exceedingly small fraction of all the atoms of fluorine (for example) would be in a state to absorb the lines in question (which in this case lie in the red). Calculation shows that unless fluorine was more abundant than any other metals, or even than oxygen, its lines would not be strong enough to detect. The same is the case for all the other "missing" elements which are at all abundant on earth or even moderately rare there. The more striking cases of apparent absence are thus fully explained.

Some of the heavy metals such as bismuth, have the strongest line in the accessible region and if there was much of them in the sun we would surely detect them. But all the heavy metals, even those whose lines appear, are present in but small proportions and a moderate decrease in abundance would put them beyond detection. So even in this last instance there is no evidence of any real difference of importance between the composition of the earth and sun, beyond those which may be reasonably explained by the circumstances surrounding the origin of our planet.

IN another respect, however, the difference in composition between the earth and the sun is very great. The earth is made up almost entirely of chemical compounds. Metals in the free state are rarely met with, though platinum and a few others are sometimes found "native." Among the non-metals only the oxygen and nitrogen of the air are counted "free" and these are not composed of isolated atoms but of molecules in which a pair of atoms are tied very tightly to one another. Only the inert gases—neon, argon, and the others—which can not enter into combination are found on the earth in the atomic state.

But upon the sun isolated atoms are in the overwhelming majority. All the spectral lines of which we have so far spoken are produced by free atoms and many atoms which have not only been released from combination, but themselves partially decomposed by the loss of an electron.

This, of course, is a result of the sun's high temperature and so obvious a result that it has been understood and generally accepted since Lockyer pointed it out in the very dawn of astrophysics.

It was not until the last 20 years indeed that any definite evidence of the presence of chemical compounds in the sun's atmosphere was forthcoming. About this time it became clear that the molecules of such compounds, if they stood up at all without decomposition under the rough treatment required to get them to emit light, gave spectra of a very complex sort, consisting of thousands of lines closely packed together in certain regions to form conspicuous "bands." A few such bands appear in the solar spectrum, the most prominent being in the violet (Fraunhofer's G group) and in the ultra-violet (the well known "cyanogen" bands).

WITH the rise of spectroscopic theory it was shown that the complexity of these spectra arose from the fact that a molecule can do many things which an atom can not. The separate atoms within it (or at least their heavy nuclei) can oscillate, changing their distance apart, while at the same time the molecule as a whole rotates about an axis. We have now in many cases a good idea just what processes correspond to each of the multitude of lines in the band spectrum. Molecules of three or more atoms are too complicated to tackle as yet, but when there are only two it is possible to find the distance of the two nuclei, and various other things. Spectra due to a number of different molecules have thus been definitely identified in the sun, the list including CN (cyanogen), C_2 giving bands in the yellow and green, CH (the G band), and OH and NH (bands in the ultra-violet).

Very little knowledge of chemistry is required to make the reader exclaim at these formulae. CH_4, H_2O, NH_3—these represent very familiar molecules; but what are these other queer things? Exactly what the formulae indicate. They are not familiar molecules of methane, water vapor or ammonia, but *fragments* of these molecules already partially though not completely decomposed. The CN molecule, too, is recognizable not as that of the well known cyanogen gas, C_2N_2, but as one half of it.

Clearly, then, at the temperature of the sun the dissociation of such molecules as are familiar to us has already advanced far, though it is not complete.

The amounts of these various molecules in the sun's atmosphere can be found by the same methods which are used in the atoms. They come out small. Cyanogen, the most abundant of them, is present in smaller quantities than even the rare element scandium, and for every such molecule there are thousands of atoms of uncombined carbon or nitrogen. This is in harmony with the fact that for stars only a little hotter than the sun the bands disappear, showing that all the molecules are dissociated into atoms. In the sunspots, which are well known to be cooler than the rest of the sun, new kinds of molecules are recognizable but show no bands in the solar spectrum—hydrides of magnesium and calcium, MgH and CaH, and oxides of titanium and boron, TiO and BO. These molecules are evidently decomposed at normal solar temperature. Like the others they are chemically incomplete or "unsaturated"—the familiar stable compounds being MgH_2, CaH_2, TiO_2, and B_2O_3.

It seems curious that only these fragmentary molecules should reveal themselves, but there is a good reason. The spectra of molecules consist partly of bands which are absorbed by the molecule in its normal state, and partly of those which are absorbed only by excited molecules loaded with energy like the excited atoms discussed above. The number of excited molecules, too, would be a very small fraction of the whole, so that only the bands absorbed by molecules in the normal state should be expected to appear unless the compound in question was present in great quantity.

NOW the analysis of laboratory spectra shows that for all the saturated stable gaseous compounds with which the chemist ordinarily works the strong absorption bands due to the unexcited molecules lie far out in the ultra-violet, while for the unsaturated, fragmentary molecules they are usually to be found in the visible spectrum or just outside it. This probably means that ordinary saturated molecules are, so to speak, so well satisfied with themselves that it takes a powerful disturbance such as is given by light of short wavelength to stir them up, while the half molecules are much more easily irritated. Anyway it explains why the latter have been depicted in the solar and sunspot spectra and not the former. There might be, however, a very considerable quantity of molecules of the stable sort in the solar atmosphere without our knowing it, since the lines which would reveal their presence are in the inaccessible part of the ultra-violet. Proof that this is actually true in the case of hydrogen has very recently been given by a brilliant young Italian physycist, Professor Piccardi of the University of Florence.

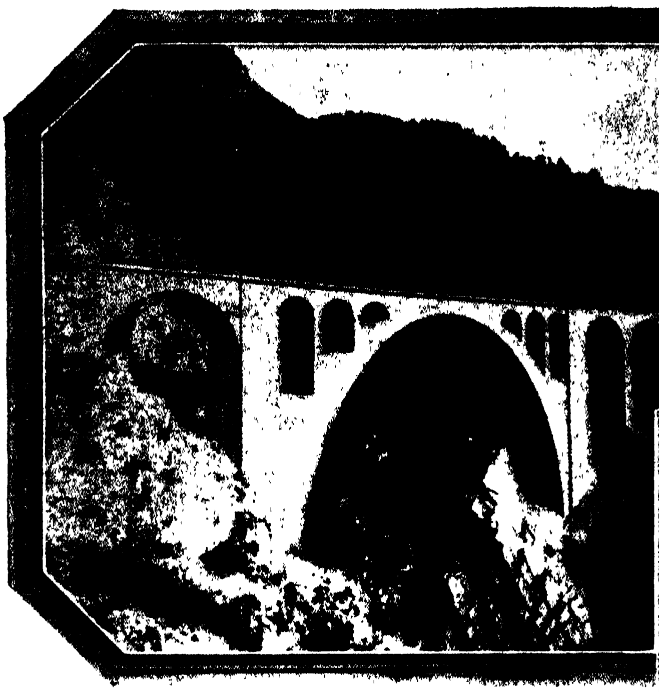
Besides the familiar line spectrum, which appears so strongly in the stars, hydrogen in the vacuum tube shows a second, and much more complicated, "secondary" spectrum which is now known to arise from the hydrogen molecule H_2. The lines of this spectrum, at least in the visible region, are not visibly grouped into bands but the spectrum has been worked out and found to be similar in nature to other molecular spectra. The bands absorbed by the unexcited molecule lie very far in the ultra-violet and the visible lines are produced only by highly excited molecules.

THE energy which is required to dissociate a hydrogen molecule into its two atoms is not accurately known and Piccardi, calculating from this, showed that at the ordinary temperature of the sun's atmosphere and the pressure prevailing there practically all the molecules should be dissociated, but that at the lower temperature of the spots one percent or even more of the hydrogen atoms might be combined into the molecules.

Working with a copy of the great Mount Wilson map of the sunspot spectrum he found faint lines in the position of most of the strongest lines of the "secondary" hydrogen spectrum—except for some which were obviously "masked" by strong lines of the ordinary solar spectrum that happen to fall close by. These lines appear only in the spots, as they should do if they really belong to H_2. Moreover they show no trace of the Zeeman effect due to the magnetic field in the spots (as lines belonging to atoms practically always do but those of molecular spectra practically never). Some of the strong lines observed in the vacuum tube failed to appear in the spots but this supports rather than weakens the argument.

This mass of cumulative evidence justifies most thoroughly Piccardi's conclusion that hydrogen molecules are present in the sunspots. The number of excited molecules which absorb the observed lines is very small compared with most other constituents of the atmosphere. But the unexcited molecules must be enormously more numerous and they may outnumber even the atoms of abundant metals like iron. Since only a small percentage of all the hydrogen atoms are combined in the molecules we have here another proof, perhaps the most convincing of all, of the overwhelming preponderance of hydrogen at the sun's surface.

It is probable that molecules as well as atoms of some of the other familiar elements such as oxygen and especially nitrogen are to be found in the sun's atmosphere. We may soon be able to calculate what proportion of such molecules there may be, but there is no hope of detecting them spectroscopically.—*On the Nile, Jan. 7, 1930.*

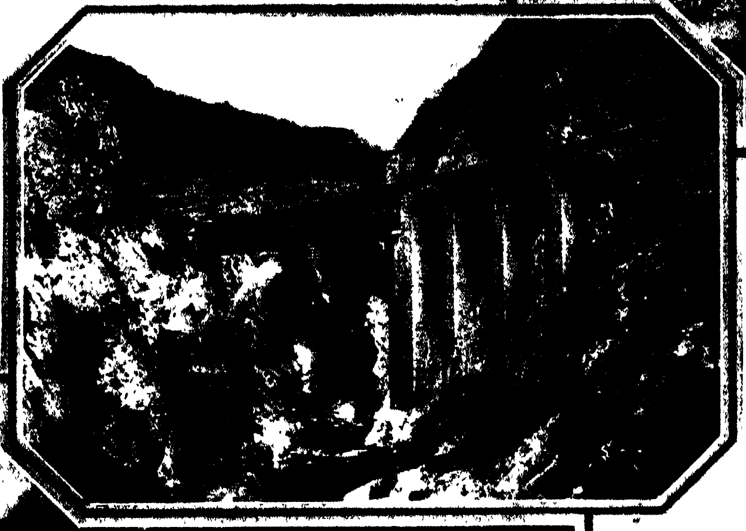


◄ ERBOSSIERA

The Erbossiera viaduct which perches on the side of a hill. It consists of a main arch span of 118 feet, one side arch of 82.8 feet, and nine approach arches of 26.3 feet

▼ DE BIANCAO

Of the two beautiful viaducts at this point, the upper one is on the main line to Nice and the lower one is on the branch to Ventimiglia. Note the lower tunnel



◄ BEVERA

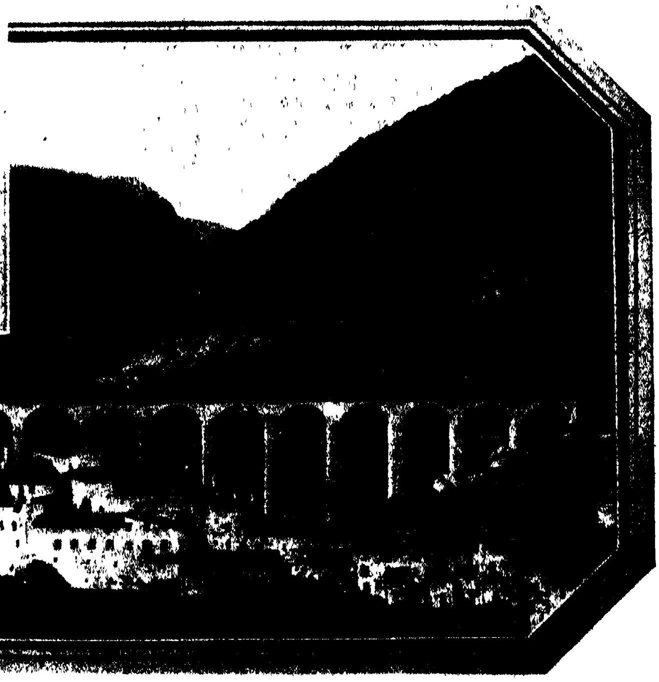
The unique transverse arch which supports two 148-foot truss spans of the bridge proper. The skew is of masonry, has a span of 82 feet, and is at right angles to the bridge. The stream is small

▲ FONTAN

Solid and arched viaduct construction on the ascent to Fontan. This was necessary because of the unstable rock formation of the mountainside. Three tunnels are visible in this picture

L'ESCARENE ►

From Nice, the line ascends the valley of the Paillon River as far as the village of L'Escarene, over which it passes on this beautiful masonry viaduct of 11 arches, each having a span of 49 feet



Beautiful Bridges On New Rail Line*

Exceptional Engineering Problems Involved in Construction of European Railway

BRIDGES of remarkable beauty, and several long tunnels, are the outstanding features of a railway extending from Nice, France, to Coni, Italy, with a branch to Ventimiglia, Italy, which was opened a little over a year ago. The new railway is approximately 68 miles in length, of which total about 39 miles are situated on French territory. Its construction presented a large number of serious engineering problems, owing to the fact that the line extends through extremely mountainous territory.

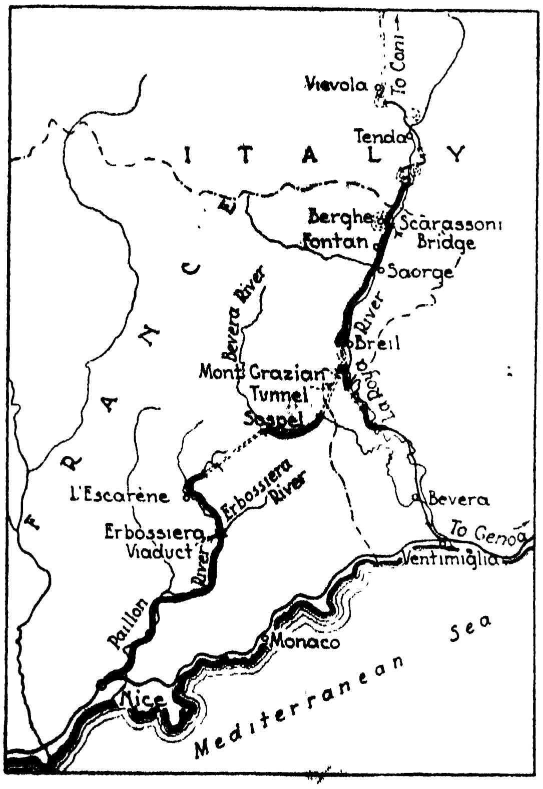
Prior to the construction of the new line there was no direct rail connection between southern France and northern Italy with the exception of the northern line from Lyons to Turin and the coast line from Marseilles to Genoa, via the Mediterranean coast. Neither of these existing lines provides a direct line from Turin, Milan, and the important towns in the plains of Lombardy to the south coast of France and the western section of the Italian Riviera, the only route to these places being a long detour via Savona.

THE need for such a direct link led to an investigation by the Italian government into the possibility of the extension of the existing line from Coni to Col de Tenda, as far as Ventimiglia on the Mediterranean. It was soon discovered that the only feasible and economically practicable route for this extension would be through the communes of Fontan, Saorge, and Breil, in the French Department of the Alpes-Maritimes.

As a result of an international conference, an agreement was signed between France and Italy in 1904, under which both governments agreed to construct, each in its own territory, a railway line linking up Nice and Coni via Sospel, while another line, leaving the main line at Breil, would prolong the railway to Ventimiglia. It is these lines which have now been completed, 24 years after their construction was authorized.

Owing to the rugged character of the mountains in the Alpes-Maritimes, it was necessary to construct no less than 45 tunnels, with a total length of 14¾ miles, nearly a quarter of the whole mileage. Of these, the longest is that under the Col de Braus—3¾ miles. In addition, the numerous ravines and deep valleys which abound throughout the traversed territory called for a large number of bridges and viaducts, many of which are of unusual interest, as they involved exceptional forms of construction.

Among the most remarkable of the bridges is that over the narrow gorge of the Bevera River. Since the location was unfavorable for the construction of a span of 300 feet, an intermediate pier was desirable, but such a pier would have almost completely blocked the waterway. The problem was solved by constructing an arch rib, approximately parabolic, spanning between the walls of the gorge at right angles to the center line of the bridge. The skew arch has a span of 82 feet, a height of 49 feet, and is 10½ feet thick at the base. It is surmounted by a bridge seat which supports two lattice steel trusses 147 feet 8 inches long. (See February, 1929, issue, SCIENTIFIC AMERICAN.) The solution of this problem consists of a variation of that employed in the "hanging bridge" on the Denver & Rio Grande Western.



SERVING A TOURIST SECTION

Map of the Nice-Coni Railway, with its branch line to Ventimiglia, showing bridges and tunnels

Another interesting structure is the Saorge Bridge which spans La Roya River at a height of 197 feet and has an arch with an opening of 131 feet 3 inches, while another remarkable crossing of the same river is the Scarassoni Bridge near the frontier. This consists of a main span comprising an open-spandrel arch of 160-foot span with its crown 148 feet above the stream. It is flanked by approaches embodying arches of 42½-foot span.

Many of the difficulties which confronted the engineers in the construction of the Nice-Coni line must be ascribed to the unstable rock formation of the Alpes-Maritimes. This is largely of a chalky nature in distorted and faulted stratification. In some cases the strata stand almost vertical or lean toward the valley so that loss of support through excavation could easily have resulted in great slides. As a result, large expenditures were made for retaining walls, while on some mountain slopes where ordinary practice would call for side hill cuts, it was deemed unsafe to disturb the slope by excavation and the line was supported on solid or arched masonry viaducts.

IN addition, it was found that the water from many underground water pockets caused the rapid disintegration of the mortar used in the masonry of tunnels and retaining walls, and special steps had to be taken to prevent this water from reaching the mortar. The large amount of special construction which was thus necessary throughout the length of the line naturally had a marked effect on the cost of construction, which amounted to nearly 450,000 dollars per mile.

Apart from the value of the new line from an economic standpoint, it will also tend to foster a very considerable tourist traffic. Hitherto there has been little opportunity for the visitor to the Mediterranean coast to penetrate into the interior of the Alpes-Maritimes and the adjoining provinces of Italy except by the comparatively slow motor coach service. With the coming of the new railway, however, a more rapid route has been opened, which abounds in picturesque scenery and new playgrounds.

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* Abstracted by permission from article by F. C. Livingston in *Railway Age*. Illustrations courtesy *Railway Age*.

Sinanthropus, the Peking Man

As Evidence Accumulates, the Million-Year-Old Fossils Found in China Are Assuming Increasing Importance

ANTHROPOLOGISTS are attaching vast significance to the fossil finds that have been reported from time to time from the vicinity of Peking, or Peiping. As the possible significance of these fossils gradually emerges, men of science are filled with eagerness to see the excavations completed; likewise to know the full evolutionary meaning of the finds already made. It is manifestly impossible to make more than a preliminary determination short of painstaking, detailed study at present. No discovery of fossil man since that of *Eoanthropus*, the "Dawn Man" of Piltdown, England, has aroused interest to such a fever pitch among anthropologists.

Owing to the accident of geographical location the belief appears to have become widespread that the fossils of *Sinanthropus* were those of an ancestral Chinese. No such asumption is justified by the facts, for the antiquity of *Sinanthropus* is doubtless a million years. The existence, even 10,000 years ago, of a race in a part of the world which the original owner of the bones in question inhabited 100 times as far back in the remote past is doubtless little if any more than a coincidence.

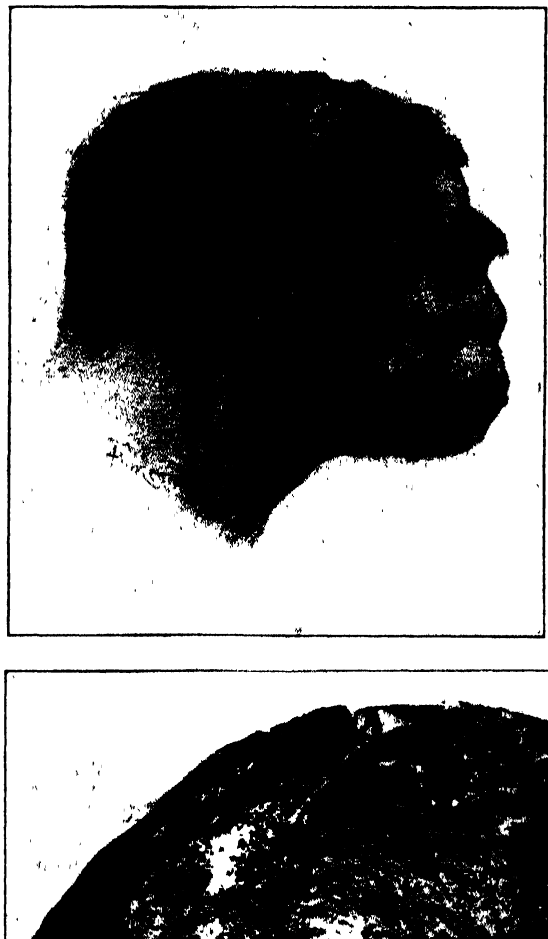
SCIENCE has but small knowledge of the origin of the human races, with regard to time, place, cause, or manner. In 1,000,000 years, or even 100,000 years, a race would have ample time to have passed through many vicissitudes, wandering far afield from its point of origin. Therefore the search for the "cradle of the human species" is likely to prove elusive. The human species evolved from some earlier animal, and this process doubtless took place gradually, covering a vast period of time. When, then, and where in its possible wanderings, can the human species be said to have been cradled? Had we a perfect rather than a fragmentary collection of ancestral fossils the impossibility of attempting to choose the "beginning" of humanness in what would then be seen to be a long, gradual transition doubtless would become more patent.

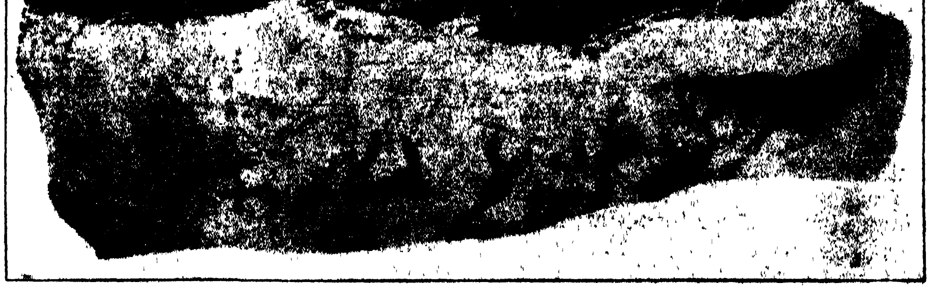
From our contemporary, the *Illustrated London News*, we reproduce the accompanying illustrations and quote the following comment on the Peking Man (by the way, the single skull found has turned out to be that of a woman), written by Professor G. Elliot Smith, Professor of Anatomy in the University of London, author of "The Evolution of Man" and other books, also of several articles previously published in the SCIENTIFIC AMERICAN, and one of a dozen leading authorities on human evolution. Professor Davidson Black, to whom Dr. Elliot Smith refers in his opening paragraph, is a Canadian anatomist attached to the Peking Union Medical College, and has had more to do with the discoveries of *Sinanthropus* than any other man of science.

"The discovery of the first complete brain-case of one of the three earliest and most primitive members of the human family is obviously an event of exceptional interest and importance. Most people are sceptical of reconstructions of ancient skulls built up from fragments. Hence the finding of a specimen which is intact provides a more convincing demonstration. Professor Davidson Black's courtesy in permitting the reproduction of the photograph, which reveals part of the wonderful fossil, makes it possible for us to appreciate something of the significance of what is probably the most illuminating discovery of early human remains ever made.

"Until November, 1928, nothing was known of the existence of the early Pleistocene Man in China, beyond some teeth, on the basis of which Professor Davidson Black, with great daring, created the new genus and species of the human family, *Sinanthropus pekinensis*, to which he assigned approximately the same antiquity as the famous ape-man of Java, *Pithecanthropus*, found by Dr. Eugene Dubois in 1891. On the last day of the excavations in 1928, however, Dr. Black's boldness was completely justified by the discovery of fragments of two jaws, those of an adult and a child, in association with the fragments of two brain-cases of corresponding ages.

"History repeated itself last winter: again on the closing





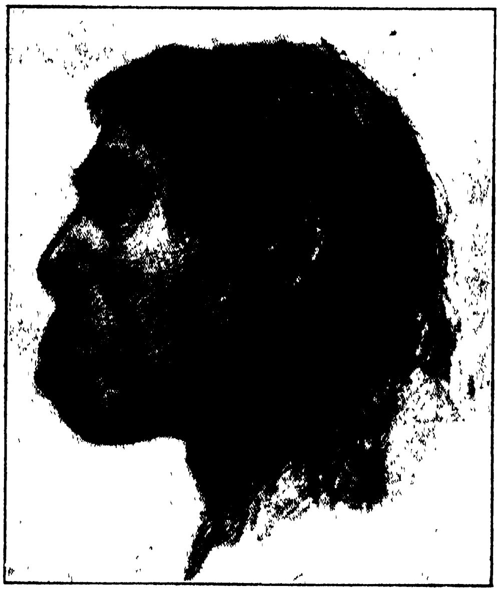
SINANTHROPUS PEKINENSIS

Above: Restoration drawing from *Illustrated London News*, by A. Forestier, from scientific data by Prof. G. Elliot Smith. *Below:* The Peking skull mounted on a plaster of Paris base day of the season's excavations (Dec. 2, 1929), the young Chinese paleontologist, Mr. W. C. Pei, of the staff of the Geological Survey of China, while excavating the sheltered recess of the main deposit at Chou Kou Tien, discovered the greater part of an uncrushed adult skull of *Sinanthropus pekinensis*. Mr. Pei at once recognized the importance of the specimen, and personally carried out the difficult work of excavation and preparation of the block of matrix in which it lay. It is entirely due to his skill and devotion that this bulky mass, with its unique and fragile contents, reached the Peking Laboratory quite undamaged.

"CONTRARY to the reports which have been circulated, no skeletal parts other than the skull and numerous isolated teeth have been recovered during this year's excavations. The different sites where *Sinanthropus* has been discovered in the Chou Kou Tien deposit are all clearly contemporaneous with one another, being Lower Quaternary in age. The evidence collected in a preliminary report on the geology and paleontology of the site by Père Teilhard de Chardin and Dr. C. C. Yong definitely establishes this fact. Though hundreds of cubic meters of material have been examined, no implements or artifacts of any kind have been found, nor has any trace of the use of fire been observed.

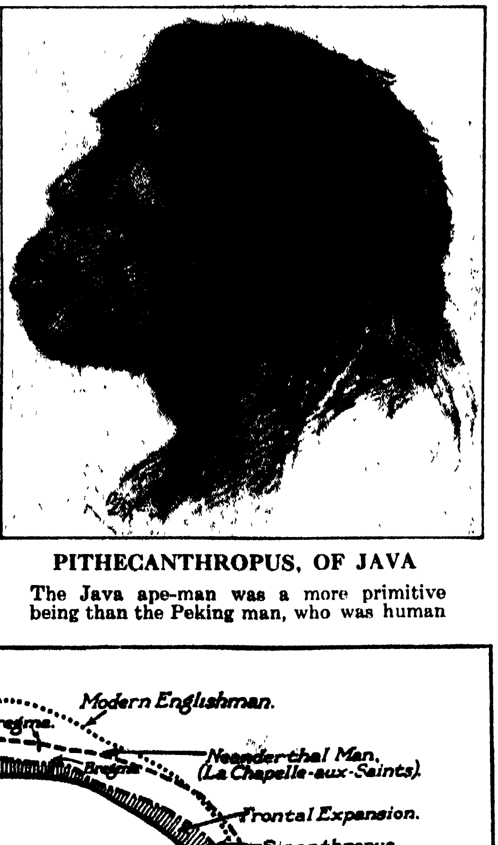
"The photograph of this skull enables us to get a much more exact idea of the nature and affinities of this early inhabitant of eastern Asia than earlier descriptions conveyed, and we are able to correct misunderstandings arising out of the telegraphed reports. The greater part of the left side and the forepart of the base of this unique skull is still embedded in a block of very hard travertine. The vault, from its massive brow-ridges in front to the back of the skull, and the whole right side seen in the photograph, were embedded in a relatively soft matrix, which has now been removed. The brain-case has been almost completely preserved, while most of the facial region would seem to be lacking.

"The skull of *Sinanthropus* is of approximately the same length as that of *Pithecanthropus*, and, like the latter, is provided with massive brow-ridges. However, *Sinanthropus* differs from the Java ape-man in the following important features: there is a slight filling out of the forehead; expansion of the localized parietal eminences on the sides of the head above the ears; and a greater height of the vault. All these differences point to a relatively greater brain capacity in *Sinanthropus*. The mastoid processes (not seen in the photograph) are small and rugged. The sockets in which the lower jaw articulated are well preserved on both sides, a circumstance which will be of great value in the restoration of the lower jaw from the fossils recovered in 1928. While the new specimen bears out what little was already known from the fragments found in the previous year, the perfection of its preservation will enable much to be learned that is now obscure concerning the evolution of the head in early man.



EOANTHROPUS, PILTDOWN MAN

Like the drawing below, this was made by A. Forestier from Prof. G. Elliot Smith's data

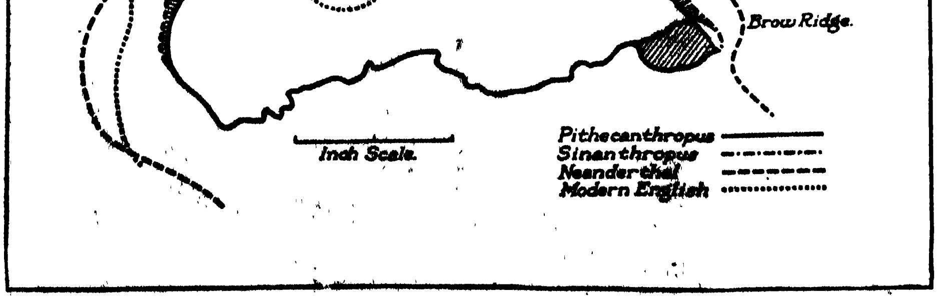


PITHECANTHROPUS, OF JAVA

The Java ape-man was a more primitive being than the Peking man, who was human

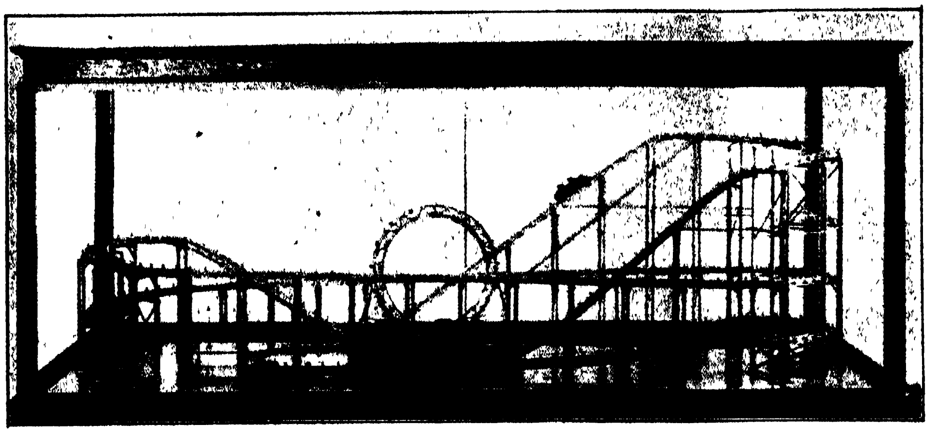
"TO show the distinctive characters of this newly found specimen, its outline, as seen from the right side, has been superimposed (in adjoining diagram) on similar projections of the cranial fragment of *Pithecanthropus*, the La Chapelle skull (Neandertal species), and a random sample of a modern Englishman's skull. Neandertal man and *Pithecanthropus* have been chosen for comparison because the new skull presents a much closer analogy to these two types than it does to the Piltdown man. There is a similar flattening of the skull, and all three have very pronounced eyebrow ridges. It will be seen, however, that in the frontal region there is a distinct fullness of the skull of *Sinathropus* in comparison with that of *Pithecanthropus* in the region marked 'frontal' in the drawing; and that the skull is slightly loftier. According to the report (quoted from Professor Davidson Black), there is a greater fullness in the parietal region marked 'P' in the diagram, which is one of the significant areas in which the human brain differs from that of the apes, and modern man from primitive man.

"The skull is, therefore, one of particular interest."



THREE FAMOUS FOSSILS COMPARED

A drawing by Professor G. Elliot Smith. Skull of Peking man compared with the Java ape man, Neandertal man, and modern man. Shape, not size, is the principal criterion



"LOOP THE LOOP"

This daring amusement device of 1901 consisted of a roller coaster with a loop in the center. The car is raised to the highest point. The centrifugal force prevents falling out

Coney Island's Museum

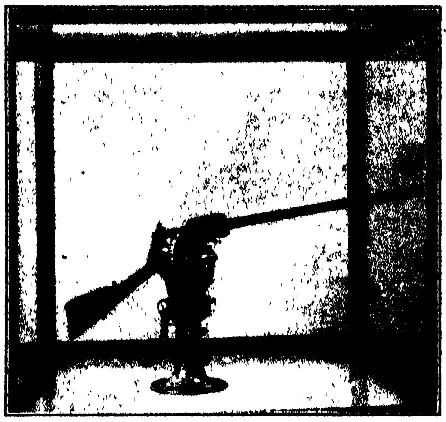
The First Institution Designed to Show Human Play-Reaction

IN a small building not far from the Coney Island boardwalk, where pleasure-seeking crowds pass up and down, is a museum which epitomizes the whole idea of the amusement center. This summer resort furnishes facilities for enjoyment which are fully equal to its more aristocratic New Jersey neighbors. Once you are on the wide boardwalk you have the sand, the same sun, and the same ocean. In no other country can such a fine sea resort be reached from a center of population, for only five cents. You can go from Queens Borough through Manhattan and Brooklyn to the "Island" for a nickel.

This summer will probably see plans mature for a larger museum building located on Ocean Parkway and accessible from all quarters. The City of New York will give a plot of ground of sufficient size to build a museum which will be adequate to the subject and which will be a fitting monument to the period of the Elegant Eighties and the Golden Nineties when the amusement enterprises of Coney Island were raised to a high, clean level. This was done with the aid of a band of inventors who are to be commended for their efforts to promote a good time for many who live a rather drab life and whose occasional outing by the sea gives healthful relaxation.

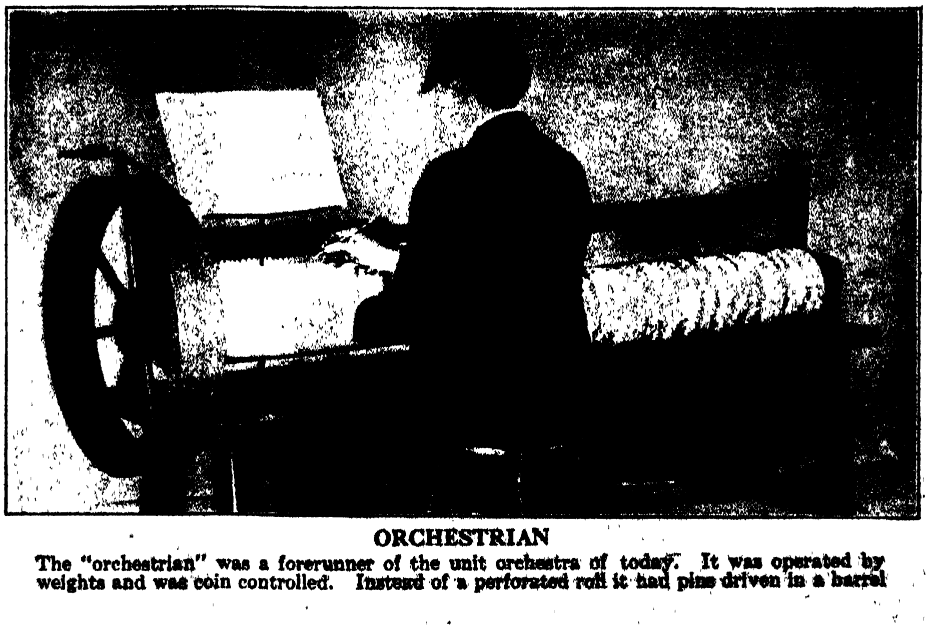
THROUGH the courtesy of Mr. William F. Mangels, himself a well-known inventor of amusement devices and one of the moving spirits in the enterprise, we are enabled to give our readers the first description and illustrations of the "American Museum of Public Recreation."

At present the Museum is housed in a temporary laboratory and storehouse on West Eighth Street, on the corner of Sheepshead Bay Road. The underlying plan is to resurrect the Coney Island of other days from authentic sources. This is the first institution ever devoted to the showing of the human play-reaction as expressed through facilities which man has created and developed. Recreation has become a scientific study in recent years. The establishment of a museum which will show the genius and development of outdoor amusements, the change in public taste and demand from year to year, and the psychology on which the success of recreations depends, fills a well defined need. The functions of such a museum are defined in the Charter which states that the institution acts "as an historical museum of public recreation exhibits, with power to collect and publicly exhibit amusement and recreational devices, novelties, inventions, mechanical and decorative amusement conceptions, and to accumulate and maintain a library and records pertaining to the history and progressive development thereof." The wealth of material



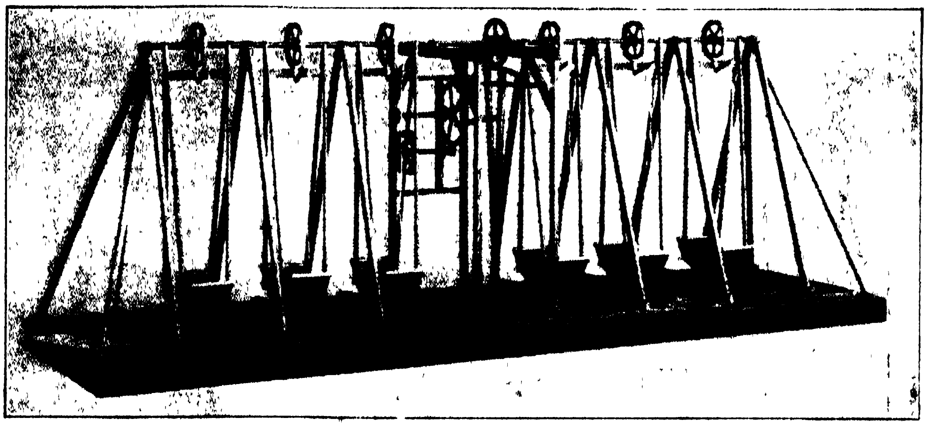
MACHINE GUN FOR GALLERIES

The gun fires by turning a crank. It can be pointed to all parts of the gallery



ORCHESTRIAN

The "orchestrian" was a forerunner of the unit orchestra of today. It was operated by weights and was coin controlled. Instead of a perforated roll it had pins driven in a barrel available for this institution is apparent. America leads the world in the production of novel recreational devices and the development of municipal playgrounds. The National Association of Amusement Parks is sponsoring the Museum.



STEAM OPERATED SWINGS

Here operation by the exertions of the persons occupying the seats was replaced by steam power. The occupants started swinging by pulling the cord which operated a band brake

HERE we find examples of the work of Frederick Thompson, who was the creator of "Luna Park," "A Trip to the Moon," and "Toyland," and who built the New York Hippodrome that is so soon to succumb to the crowbar and torch of the house-wrecker. In the Museum will also be found a unique set of carving tools, benches, hand screws, et cetera, used in carving some of the original lions for carousels by the American founder of this industry, G. A. Dentzel. The collection of musical instruments is highly interesting and includes some of the early "orchestrions" operated with pin cylinders and weights. There is also a monkey organ 150 years old and a street piano of 1862 which inspired the ever-popular "Sidewalks of New York." Most of us have forgotten the "melodian" but an example is here. Some time the phonograph of 1885 will be a great rarity, but one will be found in this collection.

THE MODEL MAKER

The clever little models are made to scale. The "loop the loop" model shown on opposite page cost 3200 dollars to build

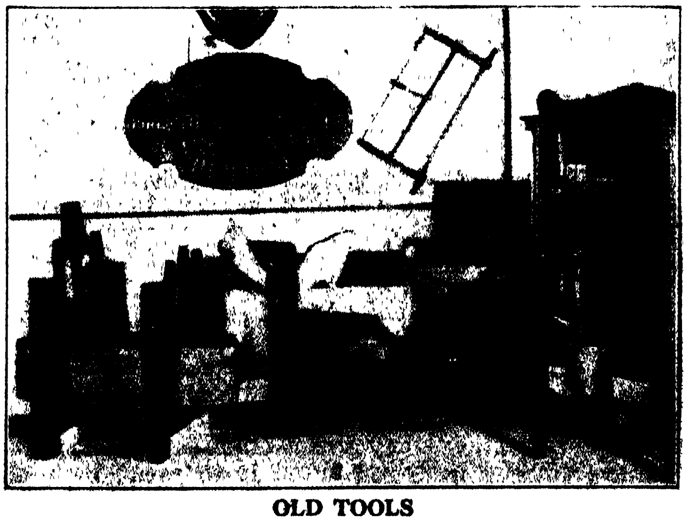
A PAIR OF LIONS

Here we have a pair of carousel lions. There is approximately one hundred years difference in their ages

Some of the framed photographs and posters are priceless to the collector and student. Many of the devices can only be shown by models, their bulk is so great. A model of a roller coaster may cost several thousand dollars. Such models are being built at Mr. Mangels' amusement device factory a short distance away, where expert model makers are engaged in their fabrication. It is fascinating to watch these clever mechanics work to the minute scale which the model demands.

Perhaps the most amusing exhibit in the entire Museum is a pair of carved lions. The smaller lion is of the vintage of 1831. It was carved by Michael Dentzel and was brought to this country on a sailing ship. The other lion was carved by his grandson, William A. Dentzel in 1926. This exhibit shows a real development in the art. We are now going to give away a secret of the business—most of the "merry-go-round" horses, lions, and other animals are now not carved at all but are cast of aluminum and are made of two pieces joined together.

The Museum is one which does not rule out modern devices. For example, Mr. Mangels exhibits one of his machine guns for shooting galleries. The revolving disk holds 60 .22 caliber cartridges. The gun is operated by turning the crank. It can be pointed to all parts of the gallery but stops prevent its being turned in other directions. The empty disk may be quickly replaced by a loaded one. The barrel is easily replaced by another if overheated.



OLD TOOLS

These old tools are priceless. Here we have benches, vises, saws, clamps, and everything the old carver needed; a unique collection

PART OF THE MENAGERIE

No, this is not the "zoo," but a collection of the playmates of children during the last century. Some of them were worn out

PIONEERS OF THE CALIFORNIA UNIT

The 1930 class at the University of California, soon after their enrollment in 1926. The successful ones will receive with their diplomas this June commissions as Ensigns in the United States Naval Reserve. Much of their training has been aboard ship

Midshipmen at 'Landlubber' Colleges

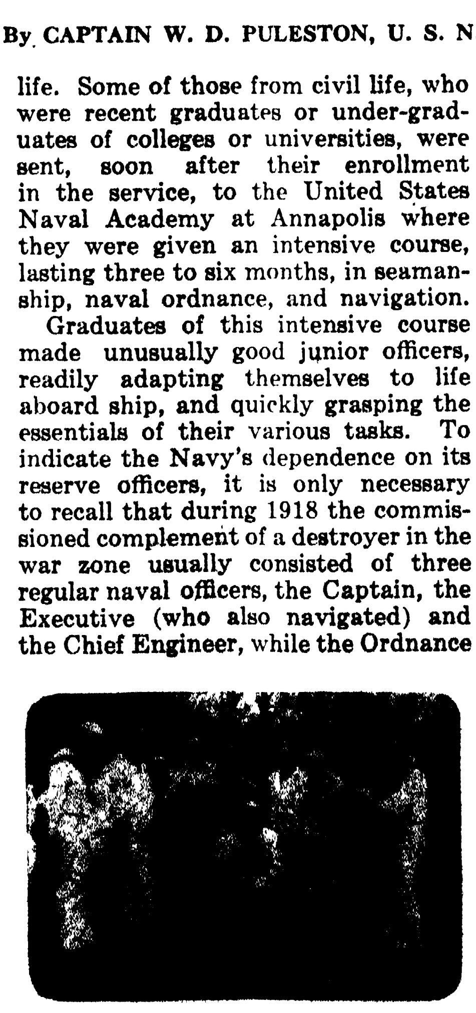
Six Great Institutions Co-operate With the Navy in Preparing Naval Reserve Officers for Sea Duty

By CAPTAIN W. D. PULESTON, U. S. N.

THE senior classes at Harvard, Yale, Georgia Institute of Technology, Northwestern University, University of Washington, and the University of California, now include for the first time a group of Reserve Midshipmen, who have completed their naval course. The successful ones will be tendered with their diplomas commissions as Ensigns in the United States Naval Reserve. In the event of war, these specially trained graduates will be qualified to take their places aboard ship as junior line officers of the Navy, carefully prepared for their specific duties aboard ship. Behind this pioneer class of 1930, there are already entered Reserve Midshipmen in the classes of 1931, 1932, and 1933, and it can now be safely stated that the Naval Reserve Officer Training Corps is fairly launched, and that each succeeding class in the years to come will graduate its quota of Ensigns of the Naval Reserve.

DURING the World War the commissioned line officers on the active list of our Navy were increased from about 2100 to about 21,000 — roughly ten-fold. The additional officers came from various sources. Many were former warrant officers and enlisted men of the regular service; others came from the Naval Militia and merchant marine; and still others came into the Navy directly from civil life. Some of those from civil life, who were recent graduates or under-graduates of colleges or universities, were sent, soon after their enrollment in the service, to the United States Naval Academy at Annapolis where they were given an intensive course, lasting three to six months, in seamanship, naval ordnance, and navigation.

Graduates of this intensive course made unusually good junior officers, readily adapting themselves to life aboard ship, and quickly grasping the essentials of their various tasks. To indicate the Navy's dependence on its reserve officers, it is only necessary to recall that during 1918 the commissioned complement of a destroyer in the war zone usually consisted of three regular naval officers, the Captain, the Executive (who also navigated) and the Chief Engineer, while the Ordnance Officer, the Signal Officer, and all the watch officers were volunteers, most of whom were college men who had successfully taken the intensive course given at Annapolis. The Atlantic Fleet, based in home waters and engaged on a huge training program, carried an even larger proportion of volunteer officers.



PRACTICAL INSTRUCTION

Students at the Georgia Institute of Technology study torpedo mechanism

The United States Army during the World War was obliged to train and commission many more reserve officers than the Navy, and immediately after the war very wisely determined to establish a permanent system that would produce in time of peace an ample supply of trained reserve officers. The Army worked so effectively that in a very few years it had available in numerous colleges and universities in every part of our country, courses of instruction that, in addition to the usual courses taken by the undergraduates, would qualify these students for appointment as Second Lieutenants in the Army.

THE Navy, also, realized the necessity of training reserve officers in peace time, but it was 1925 before authority was obtained from Congress to establish Naval Reserve Officer Training Corps units similar to the existing Army units. The Navy's delay permitted it to profit by the Army's experiences, and much of the success of the Navy's effort is due to the cordial co-operation and assistance it has received from its sister service.

The Navy's need for officers in the event of a major war, will never be as great as the Army's, so, at the start, naval units were established in only six institutions, with the intention that, as experience was gained in the operation of these units, a few additional units would be established in other institutions. In order that these courses might be readily available to American students in all parts of the United States, it was necessary to distribute them in educational institutions regionally; it was also necessary to establish them in institutions with a sufficiently large student body to insure obtaining enough students to justify the maintenance of a naval unit; and most important of all, it was essential that the standards of scholarship at the selected institutions be so high that the Navy could be sure that the students would be well grounded in all the regular university courses. Another important factor in the selection of the six institutions was the attitude of the president, faculty, and student body towards the naval unit, and it is a pleasure to record that, in all of those chosen, a warm welcome has been given naval units by the entire personnel.

HARVARD has always been conspicuous for its willingness to cooperate with the government in any endeavor, and from the beginning, President Lowell gave the new naval unit his powerful assistance. The headquarters of the First Naval District and one of our largest navy yards are in Charlestown; and their proximity to Cambridge also facilitates the administration of the naval unit, and enables the students to familiarize themselves with the operation of a navy yard and to inspect visiting ships. Much of the Navy's early history centers around Boston and vicinity, Harvard treasures many traditions of our early days, and an intangible but powerful bond between Harvard and the Navy results.

Yale, located on Long Island Sound, is no less favorably situated for a naval unit. During the World War it almost converted itself into a naval academy, and President Hadley in one of his annual reports calls attention to the ease with which Yale could be made into an emergency naval academy. Finally, the famous Yale spirit assures a fine morale among the members of the naval unit.

STUDENTS AFLOAT

Part of the unit at Georgia Tech takes a turn at the oars on Lake Piedmont

Situated inland at Atlanta, the Georgia Institute of Technology may not, at first thought, seem adapted for a naval unit, but the enthusiasm of President Brittain and the loyal support of the faculty and students have overcome the geographical difficulties. On Lake Piedmont, in the heart of Atlanta, the naval students are trained in navy cutters, to pull an oar and to handle boats under sail; while on the campus an ingeniously designed bridge, fitted with a standard compass and wheel, permits instruction in compass correction and steering. The Tech unit is very enthusiastic and always sends a large contingent on the summer cruise. The standard of scholarship at Tech is very high, and athletics and physical training are encouraged, so the student body furnishes plenty of excellent officer material.

Northwestern University, at Evanston, on the shores of Lake Michigan, lies about half way between Chicago and the Great Lakes Training Station. Like Yale, in an emergency, it could readily be converted into a naval academy. President Scott served in the Army during the World War and is still in the Reserve Officer Corps. Through his interest, a handsome boat house has been built on the campus for the use of the naval unit. Northwestern offers the young men of the middle west an opportunity to fit themselves to serve their country in the Naval Reserve.

The Ninth Naval District includes the heart of the country and embraces the populous states that border the Great Lakes, the navigable portion of the Missouri, and the Mississippi north of Cairo. It will surprise many readers to hear that this inland naval district contains more Naval Reserve officers than any other. It is expected that the graduates of the unit at Northwestern will be the future source of supply of junior officers to these mariners of our inland seas and waterways.

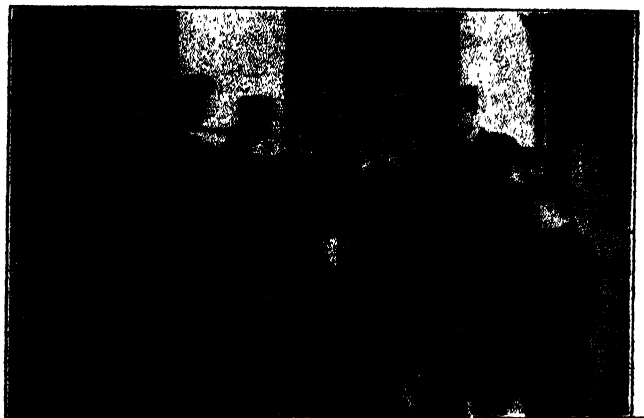
WASHINGTON University, on Lake Washington, on the outskirts of Seattle, is perhaps best known in the east for the superb crews it sends each year to Poughkeepsie. Dr. Suzzalo was President when the Navy Department asked if the University would be interested in a naval unit. In reply he telegraphed that the University of Washington wanted a unit and would comply with all conditions prescribed by the Navy. His fine enthusiasm evoked a similar spirit on the part of the Navy, which accepted his offer by despatch, so that Washington has the honor of being the first institution formally selected by the Navy for an R. O. T. C.

Dr. Suzzalo's patriotic interest in the Navy is a natural consequence of his enthusiasm for sea-going and the American merchant marine. During his presidency he was fond of calling the University of Washington a "sea-going university," and among its many courses is one devoted to the merchant marine and cognate subjects. Shortly after the naval unit was established at Washington, Dr. Suzzalo was succeeded as President by Dr. Spencer,

FOURTH YEAR EFFICIENCY ON PARADE

The two photographs above show the California unit in 1929 after three years of training. Comparison with the photograph at the top of the opposite page will indicate the progress in numbers and efficiency. Other institutions show a corresponding improvement who has continued his loyal support of the naval unit.

The University of California, located on San Francisco Bay, with one of the largest student bodies in the United States and a varied curriculum that could easily furnish a course practically identical with the one given at the United States Naval Academy, was an inevitable choice for a unit. President Campbell, a firm believer in national defense, from the beginning has been stalwart in the support of the naval unit. Among California's faculty are several reserve officers, all of whom have helped in the establishment of the unit.



NAVIGATION AT YALE

Above: a group of students of the Yale naval unit receiving instruction in compass correction. *At right*: members of the Yale unit are shown plotting ship's position

Vessels of the Battle Fleet frequently visit San Francisco harbor, and the Naval Reserve Midshipmen are cordially welcomed aboard and are thus afforded ample opportunity to combine practical work with their naval studies. The proximity of the Navy Yard at Mare Island and the dry dock at Hunter's Point permit the students to see the material side of the Navy.

There is a zestful spirit on California's campus which its students bring with them to their practical work on board ship.

THE purpose of the Naval Course offered to students at these six institutions, as stated in the original regulations prescribed by the Bureau of Navigation, is to supplement the regular courses taken by the naval students so that successful graduates of both courses will possess:

(a) A good general education.

(b) Sufficient knowledge of such subjects as seamanship, navigation, ordnance, military and international law, naval engineering, naval strategy and tactics, and naval communications, to fit them to perform their duties as Junior Officers of the Naval Reserve.

(c) A well disciplined mind and body.

(d) The quality of self-reliant leadership.

The naval courses are conducted by regular naval officers, who are chosen with care for this particular and exacting duty. They come to the campus directly from sea duty or from some important shore duty, and bring to the classroom the prestige of a successful career in the profession they are detailed to teach. The Navy Department is careful to send only successful officers to represent the Navy in the life of these populous educational centers, and to personify the naval service to the numerous undergraduates.

In some of the institutions, the regular professors assist in the instruction of the Reserve Midshipmen and, in return, naval officers are sometimes permitted to assist in other departments. Thus at Harvard, which for years has maintained an excellent Department of Navigation, the regular and naval classes in this subject are combined, and the instruction is carried out jointly by civilian professors and naval officers. At another university one of the naval officers was unusually well informed on combustion engines so his services were utilized in the regular aeronautical engineering course at the university. This coöperation directly adds to the effectiveness of the naval course and promotes a friendly understanding between the regular faculty and their naval colleagues.

Some difficulties were encountered in establishing these units, and while they have been overcome, it is well to note them. At every educational institution there is a positive lack of space because the demand for higher education in our country is actually much greater than our higher institutions of learning can supply; practically every department could advantageously use larger offices, more class rooms, and more extensive laboratories; so when the Navy appeared asking for its share of space it was crowding into an already over-populated region. Similarly the advent of a new course added somewhat to the complications already existing in the various schedules of study, but these difficulties were faced and gradually surmounted. The question of credits towards the regular degree for the successful completion of the naval course was one that required careful handling: the Navy Department required sufficient hours in the classroom and of outside preparation to enable naval students to master its course properly; the students could not give this time to the naval course unless they obtained sufficient credit towards their regular degree; the deans could not give the credit until they were satisfied of the intellectual content of the naval course and its cultural value to the student.

THE situation created a neat triangular problem between the Navy Department, the institutions, and the students, but it was solved when the deans realized that there was nothing easy about the naval course, and that the naval instructors would insist upon high standards of scholarship and in many cases would bring to their tasks the experience of an instructor or even of a head of a department at the Naval Academy.

But it should be added further that there are compensating factors. Responsible university authorities realized that the presence of a well-conducted naval unit on the campus would have a stabilizing effect on the student body, that a group of naval students who had learned from practical experience aboard ship the absolute necessity of discipline and who had unconsciously imbibed a respect for constituted authority would have a steadying effect on the other students that would be helpful to the university. And it was generally acknowledged that the quality of self-reliant leadership resulting from naval training would be of great value to the students after graduation.

Even the best universities can not produce junior naval officers without giving them actual sea duty, so the Navy Department provides that no student will be commissioned as an Ensign unless he has successfully completed one practice cruise on a battleship and all are encouraged to take practice cruises every summer during their school vacation. Students from California and Washington cruise in the Pacific and usually visit Victoria and Vancouver in addition to their home ports on the coast; students from Harvard, Yale, Northwestern, and Georgia Tech cruise in the Atlantic and usually call at Halifax, Bermuda, or Havana in addition to some of our east coast ports.

On these cruises, which last about two weeks, the Reserve Midshipmen obtain a practical knowledge of their duties at sea; they work navigation, carry out gun drills and target practice, stand junior officer watch, familiarize themselves with the routine of a man-of-war, and at a receptive age unconsciously absorb our naval traditions and habituate themselves to the customs of the sea.

IN addition to becoming acquainted with Navy personnel on these practice cruises, members of reserve units get well acquainted with each other, and while they are encouraged to retain the spirit of their own institution, their surroundings influence them to join together in one body, to develop a Naval Reserve spirit, and, finally, to merge themselves entirely with the naval service.

Besides the regular summer cruises, the Navy Department has authorized these students to embark on the regular week-end cruises given reserve officers and crews, to take passage on vessels of the fleet whenever convenient for them, provided their presence aboard does not interfere with the ship's schedule of work, and on special occasions students have been allowed to take passage on a man-of-war going from one coast to the other.

IN WORKING CLOTHES

Gun practice at Georgia Tech. Such work reflects the completeness of the course

Aboard ship, the Reserve Midshipmen are treated exactly as regular Midshipmen. Their service uniforms are identically like those worn by the regular Midshipmen except for a device on the sleeve; they mess together in junior officers' quarters usually referred to as the "steerage"; and are furnished white working clothes in which they can pull an oar, load a turret gun, crawl through a boiler, or inspect a double bottom. From the moment they are accepted as Reserve Midshipmen they are treated as junior officers and in return are expected to bear themselves at all times in an officer-like manner.

A requisite for enrollment in the naval unit is a deep interest in the Navy, which the Department hopes to make abiding, and a sincere determination to enroll in the Naval Reserve after graduation. Obviously, the government can not afford to give this training to students who at the end of four years will turn their backs on the service. There has been no difficulty in securing sufficient students who are fond of the sea and interested in naval affairs to enroll.

Wherever these young reserve officers go in the United States after graduation they will find fairly close to them some Naval Reserve unit or some regular naval activity to keep them in touch with the service. Generally speaking, it is probable that a majority of the graduates will eventually settle in or near the region of their alma mater. Consequently it is a reasonable hope that in time the Naval Reserve of the various naval districts will come to regard the institution within their district as their Naval Academy from whence they can annually expect their quota of reserve ensigns to replace those who for any reason have disenrolled or have retired.

FORTUNATELY for the success of this new Navy undertaking, Secretary Wilbur realized its importance from its inception and never failed to give it his strong support; amid the press of other duties he would find time on his inspection tours to visit units adjacent to his route and took pains to inspect the units embarked on board ship for the summer cruise.

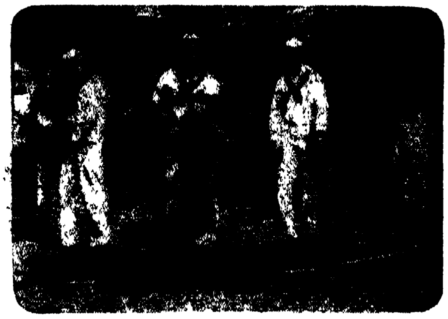
Secretary Adams, whose long association with Harvard has familiarized him with modern university life, also takes a keen interest in these naval units, as is indicated by the following extract from his letter to Mr. Richard Chamberlin, Commander American Post Number 42, American Legion, Evanston, Illinois, expressing the Department's appreciation of a medal awarded annually to the honor student of the naval unit at Northwestern University:

"The course in Naval Science and Tactics is intended to fit students to perform duties as junior officers in the Naval Reserve. But it does more than that. It brings out and ripens the qualities of self-reliance and leadership which are not only required in young officers but are essential in promoting the highest type of American citizenship. It is fitting, therefore, that recognition of merit among students of the unit at Northwestern should have been given by the American Legion.

Very truly yours,

(Signed) C. F. Adams."

In the spring of 1917 after the United States had severed diplomatic relations with Germany, and when it became increasingly evident that hostilities could not be avoided, the Navy began to enroll for active duty some volunteer reserve officers. The first enrolled were some young yachtsmen in the Second Naval District who, on their own initiative in the summer of 1915, had organized a volunteer patrol squadron of their own yachts and trained themselves under the direction of regular officers to operate against submarines. From this very small beginning, the Navy continued throughout the war to carry on simultaneously its training program and its operations against Germany.



SHIP'S BRIDGE ON LAND

Compass correction and a trick at the wheel on the campus of Georgia Tech

But our just pride in their abilities and the Navy's war achievements should not blind us to the fact that even such fine raw material required at least a year, with all the stimulus of a war atmosphere, to become useful naval officers. Manifestly, in future wars we should not depend upon the enemy giving us a year after hostilities begin to prepare our commissioned personnel.

RESERVE officers who served in the Navy during the World War should regard members of these Naval Reserve Officers Training Corps units as their natural professional descendants, and aid and encourage them in every way; and the members of these units should familiarize themselves with the achievements of the reserve officers in the last war so they will realize fully their future duties and responsibilities. As these reserve officers grow in numbers and efficiency, it is not too much to hope that their existence only may prevent a possible enemy from attacking us as did Germany on the assumption, happily erroneous, that the United States could be defeated before it could develop its latent military power.

Linemen of the Sea

When Transatlantic Cables Are Broken, Men Must Be Sent to Splice Them

By JOSEF W. VON STEIN

Courtesy Commercial Cable Company

THE CABLE IS UP

Workmen lowered in bosun's chairs attaching stoppers to cable. After cutting, both ends are hoisted on board

AN epic of the sea was enacted during the past winter in the icy, gale-torn reaches of the cold North Atlantic. A continuous struggle was staged by storm and elemental forces pitted against Man and his aides: highly developed scientific equipment and organized industry. Little did many of us realize at the time, that resolute "linemen of the sea" were fighting against overwhelming odds—midwinter cold and terrific storms - to maintain electrical communication service between two continents.

The earthquake* which upheaved the bed of the Atlantic and which seismographs registered November 18 and 19, caused havoc among the spider-like webs comprising the transatlantic cables. "About half past three on the afternoon of November 18," we were informed by Mr. A. E. Powell, Vice President and Chief Plant Engineer of the Commercial Cable Company, "we had the first intimation of the tasks confronting us, when a 'phone message from the main operating room in New York informed us that they had 'lost London' on all circuits.

"A FEW minutes later other messages began to come in from relay stations that their circuits were upset. The Canso, Nova Scotia, station reported a severe earthquake. Their instruments were badly shaken, and they believed that breaks in the cables had occurred. Routine repair work was begun, and three circuits were patched up to get the most important messages across. Within 15 minutes after the earthquake disturbance, reports came through from the Far Rockaway, Long Island, station to the effect that their tests showed that both cables from New York to St. Johns had been broken at approximately the same geographical position.

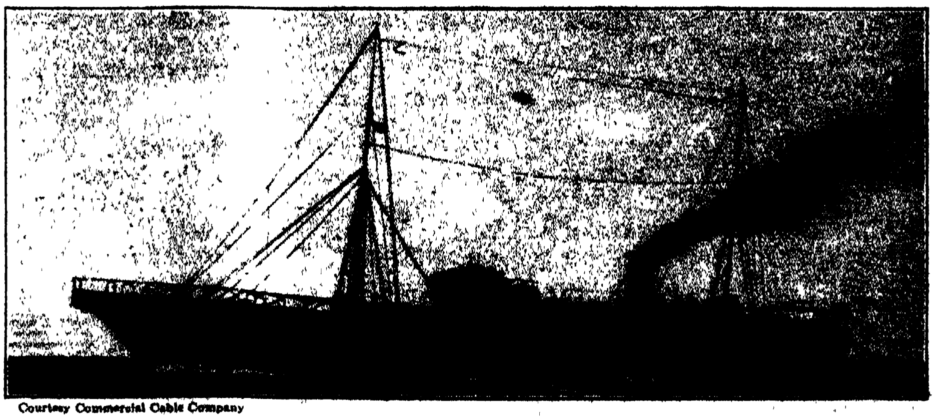
"Communicating with Mr. G. H. Ridge, Chief Cable Engineer, Western Union Telegraph Company, we learned that their tests showed breaks in both of their New York to Bay Roberts cables running through the same geographically situated sector. Meanwhile, Canso had effected temporary repair of their shaken instruments; but their tests showed the loss of the two Canso to Fayal cables which also passed through this apparently disturbed center."

The final tabulation showed that a total of 12 of the 21 cables connecting North America with Europe had been silenced. The powerful machinery of the highly organized cable industry began to function. The Commercial Cable Company's repair ship, *John W. Mackay*, was off Cape Cod repairing a feeder cable. Orders were issued to stop these repairs and rush to Halifax. Two days later this ship was well under way on its trying task in the earthquake zone.

The *All America* was in the Canal Zone. Word was flashed to this vessel and it raced northward. The *Faraday* was dispatched on November 24 from England. Meanwhile, the Western Union Telegraph Company's cable ships were also put to work. The *Cyrus Field* was dispatched to work on the 1926 fast, loaded cable, which was broken in two places. The *Lord Kelvin*, working at the time with the *Dominia* to repair the 1924 New York to Azores cable, which was broken in two places, later went to complete the work begun by the *Cyrus Field*.

THE first indication that a cable is broken or faulty is the failure of the receiving instruments in the cable stations to record incoming signals properly. When a conductor is completely broken, there is an absolute loss of electrical continuity; but in the case of a leakage in the insulation, there is an escape of current without complete loss of continuity. These leakage faults are the most difficult to localize for repair.

When the receiving instruments indicate something wrong in the line, a test is immediately made from each end of the line by means of extremely sensitive apparatus using a mirror galvanometer. Several methods of testing are used, the most general being the Wheatstone bridge balance. In this, the galvanometer, or a similar sensitive instrument, is joined up between the arms of the bridge. Since the resistance of each mile of cable was tested and charted as it was laid, accurate location of the breaks is determined by altering the resistance of the resistance box that is used, until the beam of light in the mirror galvanometer remains stationary at the neutral point. Assuming, therefore, that the known resistance per mile of cable is two ohms, and the measuring apparatus indicates a total resistance in the cable of 800 ohms, the break would be ascertained by dividing the 800 ohms by



Courtesy Commercial Cable Company

THE "JOHN W. MACKAY"

One of the largest cable ships which took an active part in the repairing of the Commerical Cable Company's broken cable. She can remain at sea for about three months if necessary

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* See page 184, March, 1930, SCIENTIFIC AMERICAN for comprehensive map of earthquake region and cable lines.

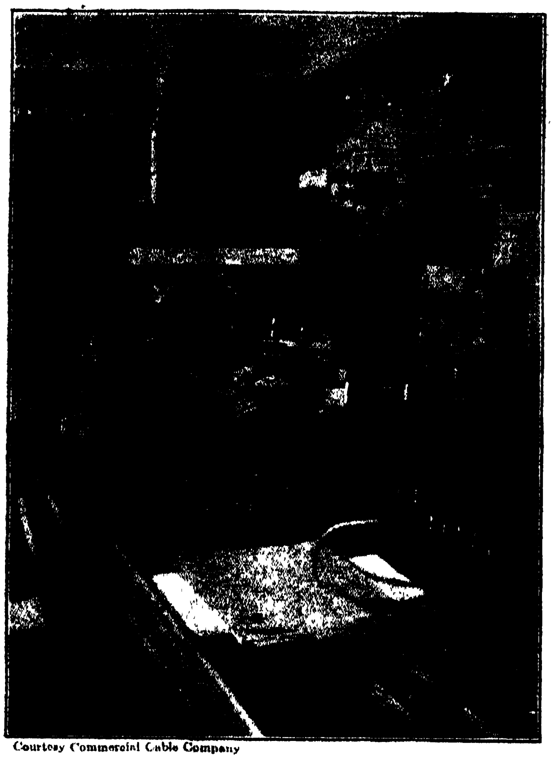
2, which would place the rupture 400 miles from the shore.

With such information, the captains of the cable-ships were able to determine, on charts showing the positions of the cables, the latitude and longitude of their projected activities.

The ship is aided in locating the supposed position of the cable by electrically driven deep-sea sounding machines which indicate the depth, nature of bottom, and temperature at the ocean bed. Knowledge of the depth aids in finding the location by comparison with known, charted soundings; the character of the bottom determines the type of grapnel to be used; and the temperature indicates what allowances should be made for this factor in repairing the cable. The sonic depth finder is also generally employed.

HAVING arrived at the apparent location, a marking buoy is moored by mushroom anchor and line. If weather conditions are satisfactory, the actual work of grappling for the cable, reposing in the soft ooze below, can begin. Inasmuch as it may take fully an hour before the heavy grapnel reaches the ocean bottom, the ship steams to a suitable distance from the line of the cable. Should there be a strong current, the grappling is done against the current. There are different kinds of grapnels, but all have similar general features. The ordinary kind for general use has a shank about four feet long with five prongs and weighs about 250 pounds. For very deep water work, a special type of grapnel is employed, which cuts one side of the cable and clutches and holds the other. This is done to avoid excessive strain on the cable, and this type was often used during the repair work of the past winter.

As the ship proceeds across the line of the cable at a speed of one knot per hour, the iron fingers of the grapnel rake the bed. The hooking of the cable is indicated on deck by a dynamometer, which registers a steadily increasing strain on the grapnel rope, or one of the crew "sits on the cable." If rocks or other obstructions are encountered by the grapnel, the fact is shown by the irregularity of the strain on the dynamometer. In grappling for a cable only an inch in diameter far below, the cable ship must be maneuvered and handled with the greatest delicacy. It is no simple problem to move a 4000-ton ship just a few yards one way or another, especially when there is a current or heavy, wintry seas. Frequently ships had to grapple for days this past winter before the telltale strain began to register on the dynamometer.


Courtesy Commercial Cable Company

▲ THE INSTRUMENT ROOM

Some of the delicate instruments aboard the *John W. Mackay*. When the cables are brought up from below, they are tested to determine the location of the fault. Cable is also tested mile by mile as it is being laid

◄ HARD WORK

Fastening cable to grapnel chains after pulling on board, to facilitate the testing and splicing operations

"When, at last, it appears that the grapnel has hooked the cable," related Mr. Higginson, who saw service as Chief Electrician on the *John W. Mackay*, "the engines are momentarily stopped to ease the strain on the cable, and orders are issued for 'full speed astern,' to keep the ship in this position. The dynamometer is carefully watched. Practical experience has taught us to know if the cable is hooked. If this is the case, word is passed to 'stand by to pick up.' There is a tense expectancy all over the ship.

"If the visibility is low, 'lights on' are ordered. The boatswain calls the watch. The ship is brought up to keep the long, heavy grapnel line leading away now from the bow sheaves. The captain stands on the foc'sle head, alternately watching the line coming slowly aboard and turning around to watch the strain registering on the dynamometer. Between times he shouts orders to the crew or to the quartermaster nearby, who stands by a duplicate engine-room telegraph. There is great danger of stretching the cable too tightly or allowing too much slack. The rise and fall of the vessel may snap the cable. The ship, barely making headway, is steered by her engines. At her slow speed, she will not answer the helm satisfactorily.

"THE 'skipper' tries to get his ship directly above the cable at the moment the cable begins to get free of the bottom. In this way, the cable will have the shortest distance to travel to the ship. The long line continues to come slowly in. It passes along the big bow sheave and over another wheel and in turn over and under the various other wheels and braking gears. At last! The beginning of the 15 fathoms of grapnel chain, polished to a bright silver by the chalky sea bottom, breaks water!"

Men are then lowered over the bow, strapped in "bosun's chairs," and "stoppers" are placed on the picked-up cable. This means that the cable is secured by chains passing over sheaves on each side of the sheave holding the grapnel line. The cable is then cut and both ends hauled on board and connected with the ship's electrical testing room. Tests similar to those described in the land terminus are applied. The end of the cable which is found intact to the shore, is then chained to a mooring anchor with a massive seven-ton buoy attached and dropped overboard temporarily. The short end to the point of fracture is either abandoned or picked up and stowed away. When the cutting type of grapnel is used, there is, of course, no short end.

The ship then proceeds on her way to grapple for the other end. The above grappling process is then repeated. This end is then spliced onto a length of spare cable on board. A skilled jointer and his assistants clean and solder together the ends of the

Courtesy Commercial Cable Company

THE FINAL SPLICE

Scene aboard a cable ship while the splice is being made between grappled cable and the new section

central copper wire or conductor. In the newest types of cables the copper wire is wound around with flexible copper tapes. Thus, should the central wire break, these flexible copper conductors will carry the current around the gap. Around this conductor is wound a single continuous strip of Numetal one eighth of an inch wide and six thousandths of an inch thick.

The total diameter of the conductor and its Numetal wrapping is just a fraction short of a fifth of an inch. Over this central core, the jointer then draws the gutta-percha covering from each side and applies two or three more coats of the same material.

Oddly enough, at this point the health of the men who work the hot gutta percha is important. If the jointer's perspiration is acid, this would cause the gutta percha to harden soon and develop a fault. Also, an imprisoned air bubble will later cause trouble since the pressure at a depth of 18,000 feet is 8000 pounds per square inch.

WHEN the jointer has finally completed his task, the joint is placed in cold water for about 20 minutes to harden. The splicer then places a serving of jute yarn around the core as a cushion for the armor wires. These wires are put back as nearly as possible in their original lay, and a heavily tarred jute yarn is put on tightly over a distance of 15 to 20 feet. The splice is complete and the cable is dropped overboard.

The ship then begins to pay out toward the end which was originally left buoyed. This is again located and taken on board. The two ends are tested in the electrical testing room by the chief electrician. If the results are satisfactory, the ends are then spliced, dropped overboard, and another cable has been put back in service.

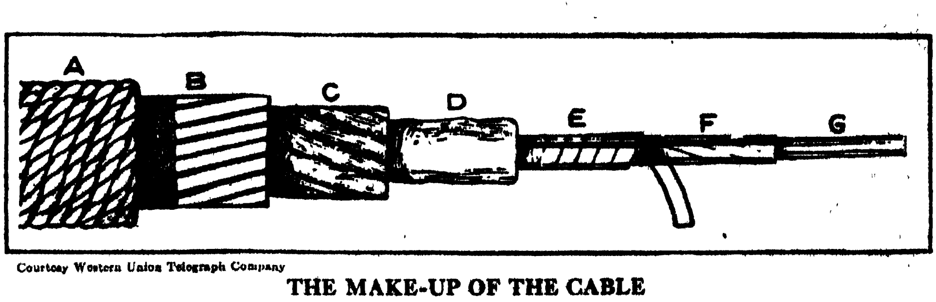
It is interesting to note that this laying of a new length of cable is not an easy matter even in calm seas. It is of utmost importance to know the topography of the ocean bed before the cable is laid, to avoid suspending the cable between submarine hills. Unless it rests on the bottom all the way across, it would be only a matter of time before it would break under the strain. Since it was feared that the earthquake had changed the contour of the ocean bottom, new surveys were necessitated. These surveys, as mentioned before, consist of deep-sea soundings which determine the depth of water, produce specimens of the bottom, and give the temperature of the water. If, by chemical analysis, it is learned that there is any mineral deposit on the bottom which would seriously affect the cable, or if the temperature should show that there is volcanic action at certain places, these places have to be avoided.

THE sounder invented by Rear Admiral Sigsbee, United States Navy, probably possesses the essential features of the others and may be taken as a typical one. It consists of a central tube fitted with valves at top and bottom, and three smaller tubes fixed beneath the central one. As the sounder descends, the valves open upward and the water rushes through. When the bottom is reached, the valves close, and a sample of the bottom water is retained. The three smaller tubes sink into the ooze, and bring specimens of it to the surface for analysis.

A low temperature increases the conductivity of the copper wire and the insulating qualities of the gutta percha covering, and is therefore desirable for cables. It is known that a conductor when normal gives a certain resistance per nautical mile at a given temperature. Thus a knowledge of the temperature of the bottom is indispensable for accurate results should the cable require testing for some future break, and in taking soundings a thermometer is always attached to the wire a short distance above the sounder. As we know, an ordinary thermometer cannot be used in great depths as the pressure causes an error of 8 to 10 degrees, Fahrenheit, and has been known to cause implosion of the bulb. Thus, for deep sounding, a special thermometer, the Miller-Casella, is used. The bulb of this instrument is enclosed in an outer bulb three-quarters full of alcohol. Before this outer bulb was sealed, the alcohol was warmed to expel some of the air. Between the two bulbs there is formed a cushion which takes up the pressure, and the inner bulb remains unaffected.

ONE of the most interesting spots on board a cable ship during the laying of new lengths of cable is the testing room. In front of a table covered with various testing devices, sits an electrician, watching a spot of light as it sways to and fro on a graduated scale. This spot is the reflection from the galvanometer mirror, and the swaying movement is caused by the induced currents set up in the coiled cable by the rolling of the ship. At the end of every fifth minute the spot gives a kick sideways on the scale, and the electrician duly notes its magnitude. This kick is caused by a signal from the shore, and proves that the continuity of the conductor is being maintained.

During this phase of repair work, careful nautical records are kept. When the length of cable has been laid, a copy of these records and charts are filed for future reference, together with results of tests and electrical measurements by engineers at both ends of the line. These records and data may prove useful at some distant date in case trouble is again experienced with the cable. It is safe to assume, however, that not one of the men who took part in the gigantic repair job of the past winter, is anxious for this time to come; for the work is infinitely hazardous and difficult.

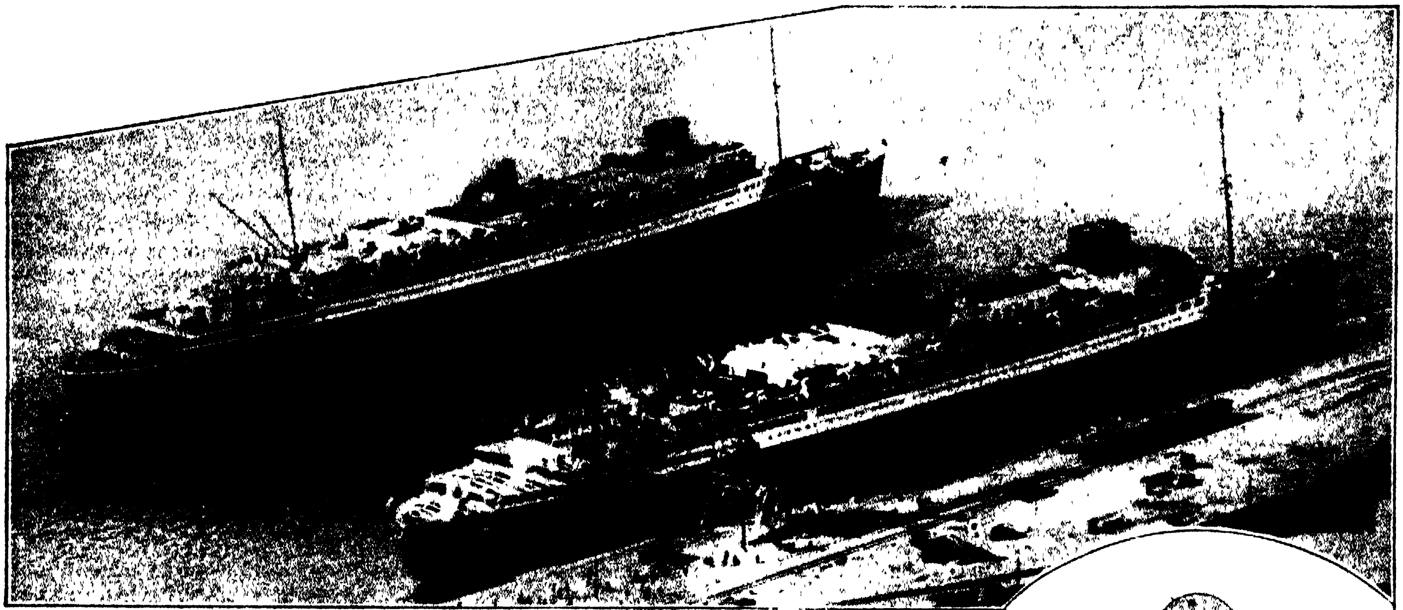


Courtesy Western Union Telegraph Company

THE MAKE-UP OF THE CABLE

New fast cables are made as follows: A, tarred hemp cord wrapping; B, steel armor wires; C, jute cushion; D, gutta-percha insulation; E, Numetal; F, copper tape; G, copper conductor

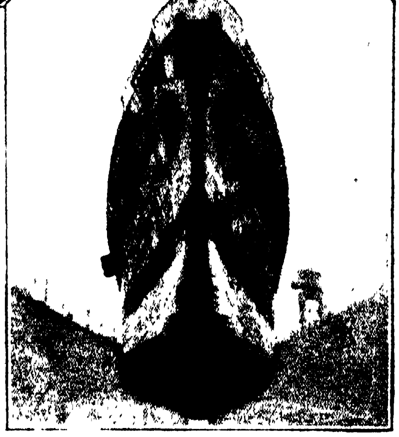
Speed Queen Smashes Sister's Record



"EUROPA"

Above The *Europa* at the dock, with her sister ship the *Bremen* alongside. The *Europa's* time from Cherbourg to Ambrose Lightship was 4 days, 17 hours, and 6 minutes, beating the *Bremen's* time by 18 minutes. Note the smoke stacks in the funnels and (*left*) the illuminated sign

All photographs courtesy North German Lloyd

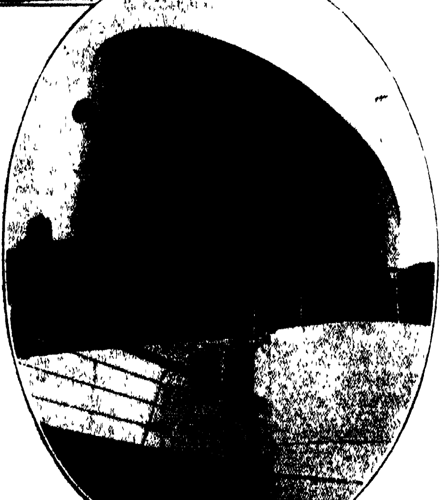


"SLIGHTLY BULBOUS"

The rounded bow was forecast after the World War, when sharp-bowed liners held the record. It creates dead water for the propellers, as against the outward push from a sharp bow

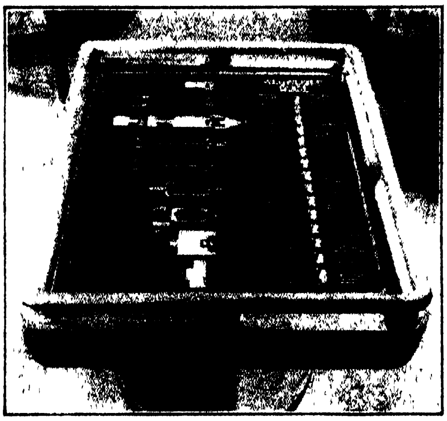
FOURTEEN-TON PROPELLERS ▼

The *Europa's* propellers are smaller than those of the *Bremen* and make more revolutions per minute. Two of them churn the water outward, and two inward. The huge turbines are of 138,000 horsepower



SIRENS

The funnels, instead of being pear-shaped, as in the case of the *Bremen*, are of elliptical shape, measuring 50 feet long diameter, and 21 short diameter. The products of combustion of the oil fuel are thrown upward by a blower system. Note the semi-concealed sirens forward



THE "WEGWEISER"

These indicators, to direct passengers, are in many locations on the boat. If you want to go to the shooting gallery or the swimming pool, just press the button opposite the name and an electric light flashes up under the part of the proper deck plan and directs you understandingly

Is There An Ether?[*]

Aid for the Layman Who Attempts to Keep Abreast of the Changing Concepts of the Modern Physicist

By PAUL R. HEYL, Ph.D.[†]
Physicist, United States Bureau of Standards

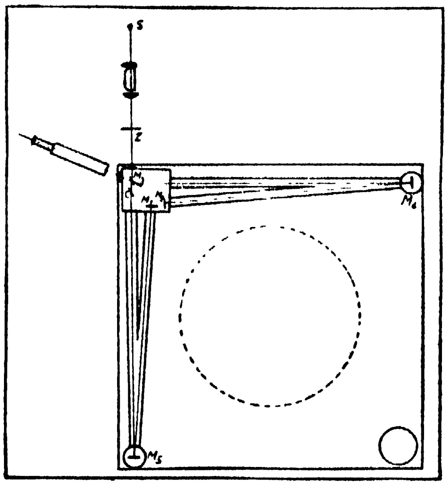
THE ether had its origin in human need and will last as long as human thinking requires it. Not always in the same form, perhaps, but unchanged in function.

The word "ether" comes down to us from the Greeks, but with their concept we have little interest. The "divine ether" to which Prometheus made his impassioned appeal was merely the rarefied upper air. The ether of physics dates from the time of Newton, who, like all the natural philosophers of his day, was greatly puzzled by the fact of apparent action at a distance. The full force of this was first felt when Newton showed that the earth's gravitative action extended to the distance of the moon. The question then presented itself: "Can a body act where it is not?" And the universal answer was: "No; it is unthinkable. There must be some connecting medium."

THUS arose the concept of the ether, at first a substance of rather vague physical properties. This hypothetical substance, while it did not succeed in explaining gravitation, at least furnished a medium by means of which it might be shown some day that gravitation could act.

In Newton's day the ether was not generally regarded as a carrier of light, for the corpuscular theory of light was then in favor. The early part of the 19th Century saw the establishment of the undulatory theory for which a medium of some kind was a necessity, and the luminiferous ether, as it then came to be called, was soon considered an indispensable part of physical theory. Later in the century Maxwell added to the duties of the ether the explanation of electro-magnetism, and with this additional responsibility came an increased measure of authority. In the eighties and early nineties the ether was everything in physical theory, and while it had not yet been shown capable of explaining gravitation it was confidently expected that this would also come to pass, perhaps in the near future.

The 19th Century felt very well acquainted with the ether, almost as well as with matter. Said the physicists of that time: "We know the ether just as well as we know iron or coal, and by the same evidence—its properties. True, it is transparent and invisible, but so is air. The ear can perceive air vibrations, and the eye those of the ether. Though it is not so simple a matter to weigh air as water, yet it can be done indirectly; likewise we can determine indirectly that the ether has a density of 10^{-18}. Moreover it must possess the properties of a solid rather than of a liquid or a gas, else it could not transmit the transverse waves which constitute light. The ether may be thought of as a vast mass of transparent, frictionless, tenuous jelly in which all material things are embedded, and through which we slip and slide without being conscious of it. Nay, matter itself may be only a kink or twist in the ether. One continuous substance filling all space, which can vibrate as light, which can be sheared into positive and negative electricity, which in whirls constitutes matter, and which transmits by continuity and not by impact every action and reaction of which matter is capable. This is the modern view of the ether and its functions."[1]



From Proceedings National Academy of Sciences. Vol. 12. p. 622

THE KENNEDY EXPERIMENT

Professor Kennedy stated that air currents and temperature effects sufficient to change the optical path one part in 1,000,000,000 would produce the ether-drift effect Miller obtained, so he sealed up his apparatus in a closed atmosphere of helium. Otherwise the set-up was the same in principle as that of the Michelson-Morley and Miller experiments. It was compact—about one yard square

But with the 20th Century there came the new physics with its revolutionary concepts. How does the picture of Nature look at present?

The jelly-filling of space is gone; matter can no longer be distinguished from electricity; the atom is a little bunch of waves traveling like a moving corpuscle; space is curved, and this causes gravitation; energy is atomized into quanta—

But stop! Let us catch our breath! Where is the ether? Is there anything left of it? And how are we ever going to get along without it?

These are very human questions. They suggest the alarm with which inherited tradition has ever viewed the iconoclast. It is easy enough to break down, but what have you to put in its place?

I think that a little study of the subject will show that the 20th Century has changed the form rather than the function of the ether; that action at a distance is as great a challenge as ever, and that modern physics binds every particle of matter to every other no less closely than did the older theory.

IN common opinion Einstein perhaps bears the blame for doing away with the ether. It is true that he asserts that there is no force of gravitation between the earth and the sun, and therefore it would seem that there need be no medium to serve as the physical basis for such an attraction; but the circular orbit of the earth must be accounted for, and this is how he does it.

Gravitation is not a pull, but a push. The earth is not drawn toward the sun by some mysterious force, but pushed out of what would otherwise be a straight course by—space itself!

Sink a large shallow bowl into smooth ice with the upper edge flush with the frozen surface. Stand off a little distance and send a golf ball rolling over the ice toward the bowl. What will happen?

That depends on the speed of the ball and on where it strikes the bowl. If it strikes well to one side and if it be not going too fast the ball may be captured by the bowl and describe several circles before settling to the bottom. But if it is going fast enough it may climb out of the bowl and proceed again in a straight line over the ice, after suffering a slight deflection from its original course. This deflection, or circular motion, as the case may be, does not mean that there is any force of attraction originating at the center of the bowl; the curved path is caused not by a pull but by a push of the curved surface of the bowl against the moving ball.

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[*] Publication approved by the Director of the Bureau of Standards of the United States Department of Commerce

[†] See "Among Our Contributors," page 421

[1] Composite of Kelvin and Lodge (1882)

In a similar manner Einstein says that the motion of the earth in a circular orbit is due to a push from curved space, and that this curvature of space is caused by the mass of the sun. According to Einstein, space is not mere emptiness, but a sufficiently robust entity to be curved and to deflect the earth. It is this very resistent space itself that forms the bond of union between the sun and the earth and relieves us of the necessity of assuming action at a distance.

RATHER a neat substitute for the ether, is it not? We need no medium filling all space if space itself is capable of doing the trick. And after all, whether we spell the connecting medium E-T-H-E-R or S-P-A-C-E—what does it matter?

Let us now look at the latest concept of the atom. I do not mean the Bohr atom, though to many this attractive planetary concept still represents the 20th Century idea. The readers of the SCIENTIFIC AMERICAN know that the Bohr atom has for some time been superseded by a more powerful and plastic form—the wave atom of Schrödinger. According to this concept an atom is a little bunch of vibrant energy, spreading out in all directions and thinning as it goes, so that all atoms are connected, though rather tenuously, into one great vibrating system. And what is it that vibrates? Electricity.

Schrödinger assumes a filling material in space, a universal electric plenum which in vibration constitutes matter. Here we see again our old friend the ether in a new disguise. There is no escaping it. Scientific thought demands it and inventiveness supplies the demand under a different form suitable to the changed times. The ether is indeed protean in its properties, all things to all men. From the vague, imponderable medium of Newton's day we have come by way of the tenuous jelly of the 19th Century to the curved space of Einstein and the universal electric plenum of Schrödinger. In one form or another the ether will last as long as human thinking requires it.

But, then, is the ether nothing more than a logical proposition? What does experiment say? Can it give us no evidence of the ether as a physical reality?

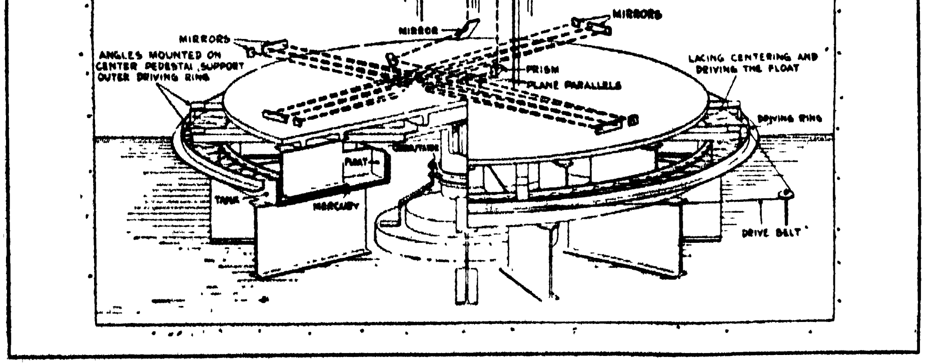
Apart from the ever present evidence of our sense of sight and the stars of heaven there is no evidence available. Many times has the attempt been made to detect the ether by our motion through it, but to no avail. Not one but several independent lines of evidence concur in this negative answer.

But, you may say, is there not at least one positive result that of Miller? And does not the evidence of one skilled observer who has seen an elusive phenomenon count for more than the negative testimony of the many who have failed to notice it? This is often true, but it happens that in this case the presumption is exactly the other way. The well known Michelson-Morley experiment is carried out by means of interfering light waves. The adjustment is one of extreme delicacy, difficult to obtain and to maintain. It is a very easy thing to get an apparent positive result and a very difficult thing to avoid it. It is a matter of wonder and admiration on the part of those who know the ropes that Michelson and others should have been able to reach their negative conclusions.

For there have been others. Miller's first announcement stimulated a number of experimenters in Europe and in this country to repeat his experiment under different conditions, some in a balloon, some on a mountain, and some on earth at sea level, and in no case was any confirmation of Miller's result reported. Of all these other experiments those of Kennedy, of California, have perhaps had most weight with physicists. Kennedy succeeded in reducing the dimensions of the classical Michelson-Morley apparatus to a relatively small volume, and by a very ingenious optical device preserved all the sensitiveness of the larger form. He was therefore able to enclose his apparatus in a case filled with helium, thus obtaining unquestioned control of pressure and temperature. And his result was negative.

EXPERIMENTERS of the first rank have more than once been self deceived. There will be recalled the case of Ramsay, one of the best chemists of England, and a co-discoverer of argon. Soon after the discovery of radium it was found that radium emanation gradually turned into helium. This was the first recognized case of transmutation among the elements, and aroused great interest. Ramsay, as a result of some very carefully conducted experiments, came to the conclusion that not only helium but neon could thus be produced, and that even copper could be changed into lithium. Other experimenters failed to confirm Ramsay's results, and it took five years to settle the question. Finally J. J. Thomson developed the unexpected fact that certain gases were retained by glass under the most severe treatment, such as heating to the softening point. Ramsay's alleged results are now of historical interest only.

And so it is with the supposed "anti-Einstein" evidence today. Miller's results stand alone. Without independent confirmation they can not gain acceptance. Half a dozen attempts at confirmation have failed, and their very failure is the best proof of their claim to recognition.

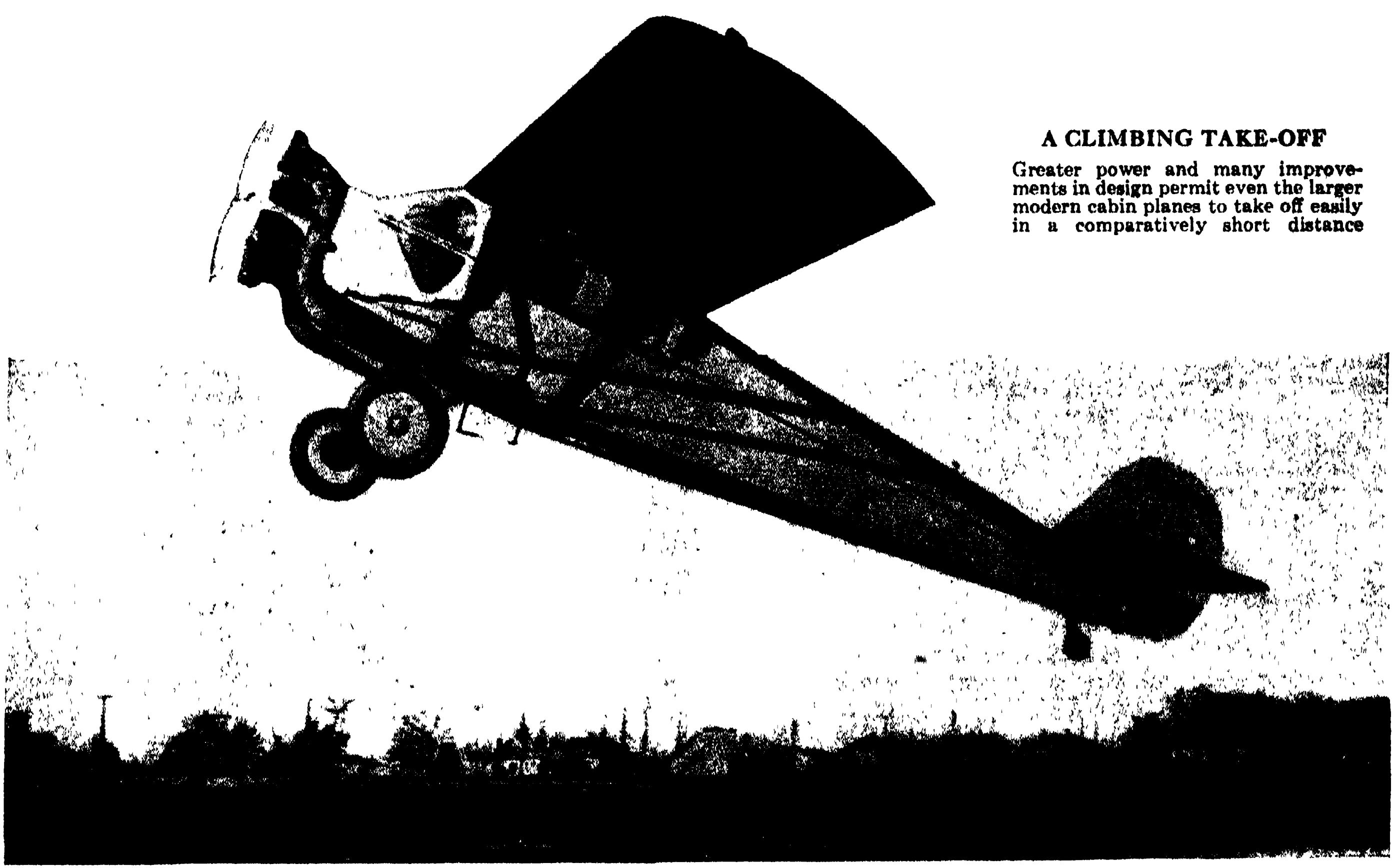

MICROMETER EYEPIECE
LIGHT SOURCE
WOODEN HOUSING MOUNTED ON FLOOR
LENS
WOODEN HOUSING MOUNTED ON TURN-TABLE
← CONSTANT TEMPERATURE ROOM →
STEEL FRAME MOUNTED ON TURNTABLE SUPPORTS EYEPIECE AND LIGHT SOURCE
MIRRORS
MIRROR
MIRRORS
ANGLES MOUNTED ON CENTER PEDESTAL SUPPORT OUTER DRIVING RING
PRISM
PLANE PARALLELS
LACING CENTERING AND DRIVING THE FLOAT
DRIVING RING
FLOAT
TANK
MERCURY
DRIVE BELT

Courtesy of Nature (London)

REPETITION OF THE MICHELSON-MORLEY EXPERIMENT

In 1926-'28 Michelson, Pease, and Pearson re-performed at Mount Wilson Laboratory the original Michelson-Morley experiment on the basis of which Einstein dispensed with the ether, in order to check Miller's findings—i.e., of an ether drift, hence the existence of an ether. Their results did not support Miller's findings, which connote the existence of an ether

¶ *"Waves and Particles" is the title of a thought-provoking article written by Professor G. P. Thomson of Scotland, and soon to be published. Professor Thomson helped prove the new wave-atom theory.*



A CLIMBING TAKE-OFF

Greater power and many improvements in design permit even the larger modern cabin planes to take off easily in a comparatively short distance

Courtesy Ryan Aircraft Corporation

Better Days for Aviation

Present Safe, Dependable Airplanes Will Be Further Improved and the Industry Placed on a Sound Business Basis

By EDWARD S. EVANS*

President, Detroit Aircraft Corporation

At a Chamber of Commerce dinner which I attended recently, two men were talking about the future of the aviation industry.

"Five years from now we shall all have our air flivvers parked in our garages, and regulating traffic in the skies will be as much of a problem as street traffic is now in downtown business sections," one of them said to me. "I have half of my investments in aviation securities, and I expect to see these make a small fortune for me in the next five years."

"You are wrong," said my neighbor on the left. "Air transportation offers few practical advantages over other means of travel. It has yet to be developed to a safe practical basis. Aviation offers a thrill to the young man and woman, and airplanes are useful for carrying mail, but they cannot compete with other means of transportation. One hundred years from now our successors in business may travel by airplane regularly, but our generation will never see aviation developed so that it is of much value to the public."

Both of these men had entirely the wrong picture of aviation, but their opinions are held by many business executives, so that it may be of interest to consider some of the questions that are confronting the industry, as well as some of the past and probable future developments. In the next few years, every executive of a large corporation, who has not already done so, will have to give consideration to the place of air travel in his organization.

In order that present conditions may be understood, it is necessary that we review briefly the development of popular interest in aviation. Colonel Lindbergh's historic flight may be said to have marked the beginning of commercial aviation in this country. Immediately after this flight, every airplane manufacturing company was flooded with orders for new planes.

In 1925 the writer made a record-breaking trip around the world in 28 days, using airplanes for a large part of the trip. Many of my friends at this time thought I was writing my death warrant every time I stepped into a plane. And yet these same men and women and millions of others all seemed to want to get into the air in 1927, and there were not planes enough to accommodate them. Commercial operators were making small fortunes from taxi hops and cross-country flights; and scores of planes were purchased for various advertising and other commercial services.

At the old San Diego plant of the Ryan Aircraft Corporation which built the *Spirit of St. Louis*, it was not unusual for purchasers to offer from 1000 to 3000 dollars over the advertised price of a ship for immediate delivery. Not one of the companies then in business was equipped for anything like quantity production, and by the fall of 1927, the company that could make delivery within two months after receipt of an order was unusual. Many purchasers were willing to buy anything that would fly, regardless of the plane's reputation or design. This surplus of orders caused the formation of a large number of new manufacturing concerns, many of which were not making planes based on sound engineering design. The crashes in which such planes figured did much to shake the public's confidence in flying. Fortunately this situation has now been corrected by the strict Department of Commerce regulations requiring engineering approval and flight inspection of every new plane, and periodic inspections of all planes used in inter-state travel.

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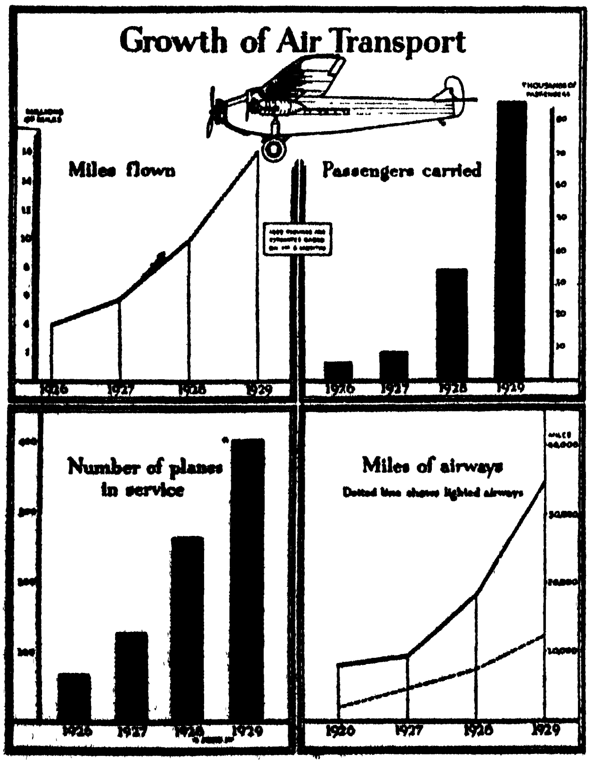
*See "Among Our Contributors," page 421.

Although there was undoubtedly far more business than the existing plants could take care of, the fact that many purchasers tried to obtain planes from two or three companies before finally placing their orders gave rise to the belief that there were more purchasers than was actually the case. Many plants were doubled and tripled in size; scores of new ones were built; and everything possible was done to speed up production.

LINDBERGH'S plane was one of the few cabin ships on the market, and the demand for that type was so great that many companies were forced to design entirely new ships. All materials entering into aircraft construction were difficult to obtain, competent men in all departments were scarce, and the industry was suddenly confronted with the new problem of quantity production. Selling planes was the least of the worries of aircraft company executives.

In view of these conditions, it is little wonder that the industry has made many mistakes. It was to be expected that certain promoters would seize upon the public's desire to invest in aviation enterprises as an opportunity to organize companies having no economic reason for existence. The history of the aviation industry has been no different from that of other new industries in this respect.



PROGRESS TO DATE, FROM 1926

A self-explanatory series of graphs which strikingly show the increasing use of airplanes in this country

It has been only recently that aviation companies could offer high enough remuneration to attract men of broad and successful business experience. Originally, the pioneer work was done either by engineers or pilots. The country owes a debt of gratitude to these men who carried on through nine years of almost insurmountable obstacles, bringing the airplane to its present stage of reliability. It was only after this tedious pioneer work had been accomplished that the country's purse strings were opened and the necessary money provided for establishment of air transport lines and aviation schools, and for the development of improved airplane designs and manufacturing facilities.

Courtesy Ryan Aircraft Corporation

THE AIRPLANE IN CHINA

The awakening interest in aviation of oriental and South American businesses and governments is expected to open a rapidly increasing foreign market for American-made aircraft

We have heard much in recent months about overproduction in the aircraft industry, and many unfounded rumors as to the general condition of the industry have given rise to opinions in some quarters that the aviation industry is in anything but a strong position. Despite the fact that aviation has just had the most successful year in its history, production did fail to come up to certain over-optimistic predictions made early in 1929. In 1928, approximately 5000 planes of all types were built in this country. Some aviation enthusiasts predicted that the 1929 production would be over 10,000. Figures for 1929 recently released by the Aeronautical Chamber of Commerce give the airplane production at 6034 planes and the value of motors and planes manufactured at 98,000,000 dollars.

In 1929 the production of planes for commercial use increased 51 percent by number and 93 percent over the preceding year in value. There is nothing phenomenal in this increase, but it is a record which few industries could point to last year, and one of the best indications of the increasing air-mindedness of the American public and business man.

The Army and Navy are taking a rapidly decreasing proportion of the total production. Seven years ago, all airplanes produced were intended for military purposes, while last year this market absorbed less than 25 percent of the production.

The greatest problem now confronting the industry is that of educating business executives to the practical value of air transportation. It is true that the industry has been somewhat backward in adopting a sound merchandising policy. From 1918 up to the present time aviation has been presented the greatest amount of publicity ever given a new industry. In some ways this has hurt rather than helped in educating potential users as to the value of this modern mode of transportation. Far too much emphasis has been placed on the romantic appeal of flying, the danger of traveling by plane, and the thrilling experiences encountered by pilots and passengers.

THE whole American business structure is based upon speed. Small inventories require fast deliveries, the many recent mergers have placed a great premium on the time of business executives, the necessity for frequent changes in the design of products requires many consultations with high salaried consulting specialists, and present conditions require frequent personal contacts between salesmen and the home office.

A survey recently conducted by the Detroit Aircraft Corporation showed that approximately 180 companies now own one or more planes. At least 20 of these own two or more ships, and it is believed that this list will be increased to many hundred by the end of 1930.

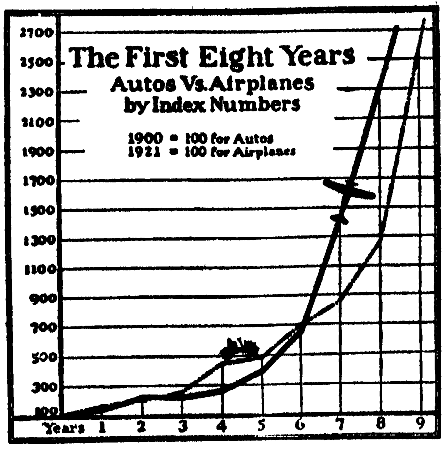
During the recent scramble to increase production in an attempt to meet the sudden demand for planes, many plants were expanded more rapidly than future economic conditions warranted. Certain companies now find themselves with uneconomical manufacturing facilities on their hands, and this will result in a certain amount of new plant construction in the near future.

Airplane buyers today are most discriminating, and usually carefully compare the performance, reputation, and price of all ships that might fulfill their requirements. This has placed certain of the smaller companies, whose planes are not soundly engineered, in a serious position, and will undoubtedly result in a great reduction in the number of aircraft manufacturing companies. The Department of Commerce recently listed 240 companies that claimed to manufacture airplanes. The great majority of these were not equipped for anything like production, and many were founded purely as a basis for stock promotion. The production of 20 of these companies accounted for 85 percent of the 1929 production. By the end of 1930, it is probable that the number of companies engaged in all phases of aviation will be greatly reduced.

The prospective investor will do well to limit his investments in aviation enterprises to those companies which have a long record of achievement behind them, or holding companies controlling a well rounded group of organizations the permanency of which is assured by past accomplishments.

THE most significant factor of the industry for 1929 was the vast amount of new money that was poured into aviation, and the many mergers which were consummated. In the last 18 months, some 60 formerly independent companies have been merged into the "Big Four," composed of the Curtiss-Wright Corporation, the Aviation Corporation of America, the United Aircraft and Transport Company, and the Detroit Aircraft Corporation. Each of these companies controls a well rounded group of from 10 to 20 organizations specializing in various lines of manufacture and operation. There are still some 20 strong independent companies that have enough reputation and financial backing to meet the larger groups in any period of competition. In view of the stock market situation, it is not probable that there will be much further consolidation during the present year except possibly in the accessory or raw material fields.

The industry is now going through the third stage of its development. From the time of the Wright brothers' first flight until Colonel Lindbergh's flight in 1927, aviation was going through an engineering development. During this period, the basic aerodynamic problems were solved; and the next 18 months were devoted to meeting problems of efficient production. The latter half of 1928 and 1929 saw nearly 500,000,000 dollars of new financing poured into various aviation enterprises, the merger of many companies, and the introduction of more highly efficient business management.



LAND VERSUS AIR

Progress of aviation compared with that of the automobile: first eight years of each

We now approach 1930, when the main emphasis will be laid on efficient merchandising and selling the public and the business man on the practical time and money-saving value of flying. Until the last six months, airplane sales took care of themselves, but now with more discriminating buyers and the ready market from commercial operators and transport lines well covered, the industry has had to branch out and seek new purchasers. Up to the last year, not more than five companies had developed anything like a nation-wide distributing organization. Now every company is making efforts to establish dealers and distributors in all parts of the country. Most of the companies are requiring that these distributors make arrangements for servicing and storing planes, and some are requiring that they carry a stock of replacement parts.

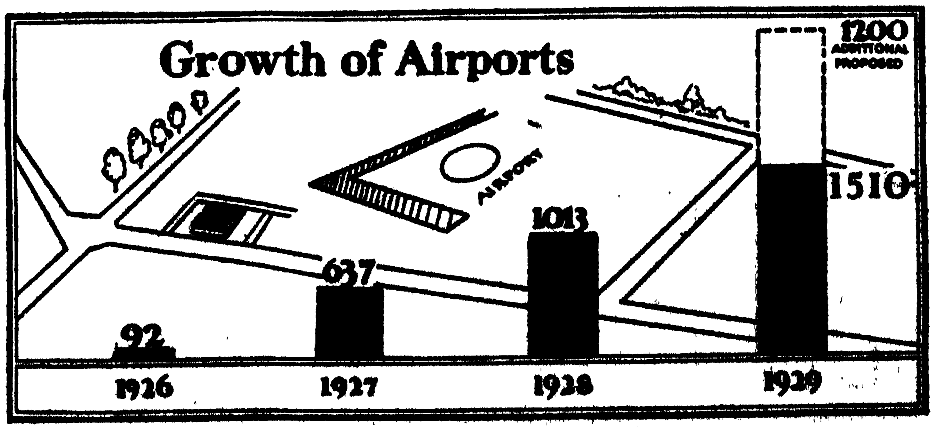
Showrooms have already been established in some of the larger cities, and the next few years will probably see even cabin planes on permanent exhibition in the business sections of every large community.

Financing plans have recently been put into effect by the better established companies, and it is now as easy to finance the purchase of an airplane as it is to buy an automobile out of income instead of capital.

Every few months we see some statement predicting that in the future we will all have "flivver" planes parked alongside our automobiles in our garages, that soon we will be flying directly to the roofs of our office buildings, and other startling developments. Such things may come in the next generation, but it is doubtful if the readers of this article will ever witness much change in design.

IT is a brave man indeed who is willing to make any predictions as to what the future holds in store for aviation, but there are some things that stand out as fairly certain. In spite of all the many new developments in the field of aeronautics, it is doubtful if we will see much basic change in airplane design in the next few years. Improvements and refinements, of course, will be made. These will increase the speed and carrying capacity, reduce the length of run required to land and take-off, give more comfort and even greater reliability. We will see many spectacular experiments in the next few years, but our present modern planes incorporate the features that make for safe, dependable operation. The engineering departments of several of the larger airplane manufacturing companies are working on radically different designs, but it will be many years before any of them will have gone through the engineering development necessary to bring them to the point of safe, practical application to air travel.

The present year will see the aviation industry settled on a definite stable business basis, with healthy increases in the value of products, and popular confidence in flying. Spectacular achievements will be less frequent, for there will be less need of them. The problem which is rapidly being solved will be to place dependable, economical aviation equipment at the convenient disposal of every individual and corporation in need of fast transportation.



EVERY SIZABLE TOWN BOASTS ONE OR MORE AIRPORTS

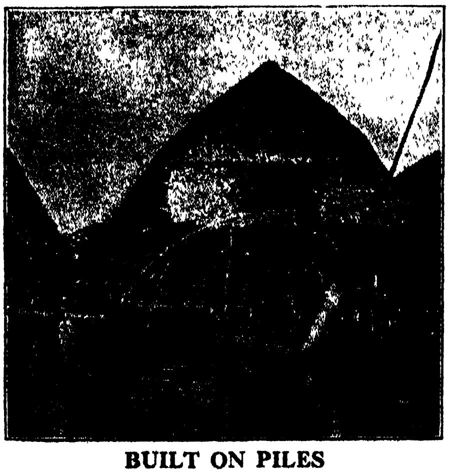
In 1926 there were very few well-equipped airports but at the end of 1929 their number had multiplied over 15 times. Now many communities have several and others are being added

Tangled Commerce Abides Where Children Smoke and Swim

The Antipodean Manus Are the Pack Peddlers of the Pacific

DR. MARGARET MEAD, Assistant Curator of Ethnology in the American Museum of Natural History, recently returned from the Pacific where she had been investigating Melanesian tribes on the islands off the coast of New Guinea. Dr. Mead's presence in the Admiralty Islands was prompted by a desire to see how children and adolescents of a primitive people compare with children and adolescents in civilized society. The Admiralty Islands formed a part of what was German New Guinea, but they are now governed by Australia under a League of Nations mandate.

These islands were selected because they have been little studied. The Manus, while a primitive people, are highly developed commercially. The Manus number about 2000 and they live in several thatched Venices on stilts like Swiss lake villages. Why these people should have left the mainland for the reefs and tiny volcanic peaks where there is standing room only, is a mystery of the South Seas.



BUILT ON PILES

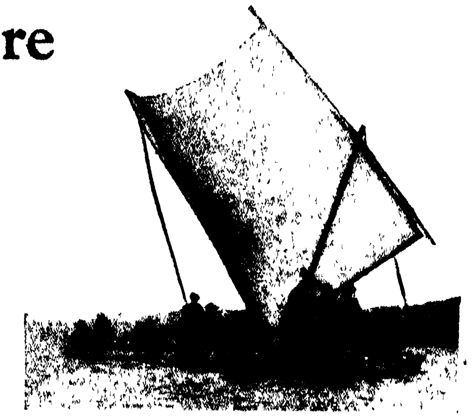
A South Sea Venice. Visiting and trading is done by water with the aid of canoes

Dr. Mead learned the language of the Manus and made an excellent collection to illustrate their manners and customs. The Manus are born traders and they exchange anything at a profit. They bring sea water to the mainland and exchange it for fresh water with those who live on the mainland. The fresh water is transported to their island home. The legal tender is dog's teeth, but the currency was becoming debased because wily traders had been importing the teeth from China and Turkey. In trading with the whites, Louisiana tobacco twist is the standard of barter and as it passes from dirty hand to dirty hand it becomes mouldy and it has to be consumed in a pipe or rolled into cigarettes with the aid of old newspapers. Children of both sexes begin to smoke at the age of three and it apparently does them no harm, nor does it stunt their growth—but it surely looks extraordinary.

GIRLS MAY SMOKE

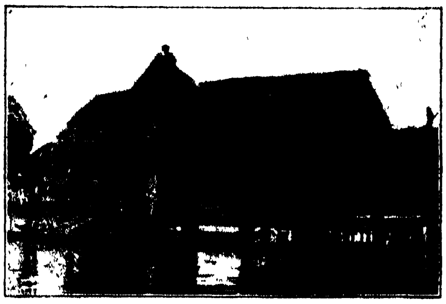
An adolescent girl holding up the skeletons of fish she has eaten. It looks like a perpetual Lent. Below is a war charm, one of the interesting specimens collected

The Manus developed the character of traders because they have a virtual monopoly on fish, while the mainlanders had virtual monopolies of everything else. The Manus catch fish, trade them to one mainland tribe for carved wood, trade the wood to another tribe for pigs, and trade the pigs to another tribe for dog's teeth, making a profit on each transaction.



A CANOE FUNERAL

The Manus of the Admiralty Islands have curious death customs. It is necessary to bury the deceased on the land



POST MORTEM HOUSE MOVING

After a death it is customary to remove a house to a new location, as is being done

The Manus are so isolated that they must use canoes or swim. Even children three years old swim and are able to handle canoes. The oldest member of the tribe can remember only one case of drowning. Two children were out in a canoe which capsized and the younger, aged three, was drowned. The father wanted the other child, aged five, punished for murder, as any five-year-old child should be able to swim half a mile and tow another one. There is eternal wrangling about nothing among the tribesmen, and they like nothing so well as to foregather at the sound of a native drum.

Their religion is based on worship of the spirits of ancestors and the community laws are maintained by religion and shame rather than by civil punishments.

BED MODEL

The Manus are the only South Sea people that sleep in regular beds. This bed certainly looks hard, especially the pillow

NATIVE ART

Here we have a wooden bowl with a crocodile's head and a pig's tail. This is probably the South Sea Islander's conception of art

THREE VIEWS OF PROGRESS IN THE DYNAMO ROOM OF GRAND CENTRAL

Moving a Substation Underground

Without Interruption of Service, Substation Is Moved Seven City Blocks to New Underground Location

By F. B. FREEMAN
Chief Engineer, New York Central Railroad

WITH the co-operation of the General Electric Company and the Thompson-Starrett Company, the New York Central Railroad Company recently completed the unique engineering feat of dismantling and transposing the Grand Central Terminal power plant—a city block in area—from its former location on the surface at Lexington Avenue and 50th Street, New York City, to a site about 100 feet underground and seven blocks distant. The present installation constitutes the world's largest power substation.

Light, heat, and power is distributed by this plant to more than 60,000 persons occupying floor space exceeding 256 acres. This plant provides the electricity which illuminates 100,000 or more electric lights, moves more than 650 trains daily, operates 325 elevators in 28 buildings, and supplies these buildings—among the largest in the world—with the hot water which heats some, the steam that heats others, and hot water for general purposes. It also distributes steam to warm innumerable railroad cars, and it compresses air, not only for railroad purposes, but to open and close hundreds of elevator doors in the buildings, to assist in cleaning, and for other uses.

The magnitude of this moving job becomes apparent when one considers that the engineers were compelled to dismantle the plant, move much of it the distance of seven blocks, and add new apparatus, without interfering with the operation of the terminal or of the trains entering it, without hampering street traffic, which is quite heavy, and finish the job on a scheduled date which necessitated the work being placed on an emergency basis, all due to the former site being required for the construction of the new Waldorf-Astoria Hotel.

The economic necessity for a change in the location of the old plant was foreseen, due to the ever-rising midtown real estate values, some years ago, and careful studies showed the advisability of moving the power plant facilities underground. It was presupposed in all plans, however, that the major apparatus would remain at 50th Street.

IN line with the company's general expansion program, the present site of the substation—an excavation about 90 feet deep and 225 feet long by 60 feet wide—had previously been made in the solid rock under 43rd Street, to accommodate a boiler plant. Two boilers were installed, with room for four more. This plant consisted of four floors: a basement, a boiler room, a meter room, and the coal bunkers. The stack extended to the top of the Commodore Hotel and was concealed in that structure.

Another vast cellar was also dug out under the southern end of the Graybar Building, adjoining this boiler plant excavation, for the accommodation of the mechanical facilities which, under the early plans alluded to, were not to be included among those to be placed underground at 50th Street at some future date. Calculations then established the fact that it would be possible to utilize the great stone vault, intended for the boiler plant, as the new site of the substation.

Ordinarily, six months would be required to draft the plans, and at least a year for the construction and removal. The lease was signed March 4, 1929, and dates set for the clearing of the various buildings for demolition. Although no drawings had been prepared, other than preliminary sketches, work was begun at once under verbal direction, followed by drawings as soon as possible. Despite these trying conditions, no change in any major plan was necessary during the course of this work.

Briefly, the following broad plans were carried out:

The steam generating plant was abolished and steam was purchased from the New York Steam Company system; and the space under the Graybar Building was turned into

Terminal's New Heat, Light, and Power Plant, 100 Feet Underground

a heater and pump room to utilize this steam to heat the immense quantities of hot water needed, utilizing tanks of 20,000- and 50,000-gallon capacity. In this space were also placed the fire pumps, hot and cold water pumps, air compressors, and other auxiliary apparatus.

The two boilers were removed from the "boiler plant" excavation, the basement was enlarged, concrete foundations constructed for the 10 rotaries, an operating floor provided for conduits and with spaces for transformers, switchboards, oil switches, and other apparatus. Also, crane girders and a 30-ton electric crane were provided.

The meter room was made into an exhaust fan room, taking air from the top of the substation and exhausting it into the boiler breeching of the old arrangement and thence up the stack. The bunker space was converted into a stand-by battery room. Here was installed an 8000-ampere battery consisting of 150 cells, each weighing 4550 pounds.

The transfer of this battery was a major problem. A city ordinance prohibits the transportation of acid in open tanks through the streets, and use was made of an underground trucking passage. Time being at a premium, the battery could not be dismantled. Part of the acid was removed, the plates were clamped in place, and each cell was placed on wheels and lowered by tackle a distance of about 55 feet. They were hauled underground by an electric truck to 43rd Street, and raised by an elevator to their present site. During the moving not a drop of acid was spilled and not a cell was injured. The care that had to be exercised may be judged by the fact that the weight of each was sustained on glass plates.

Reliability of service was assured by connecting the lighting substation at 50th Street to the New York Central high-tension system and the lighting substation at 43rd Street to the New York Edison system. This stand-by battery was removed and re-assembled and placed in service in 53 days.

The total weight of the 10 rotaries installed, their transformers and other major electrical apparatus, was 850 tons. Much of this had to be lowered piece by piece a vertical distance of 50 feet from the unloading platform to the substation main floor. All materials were moved by flat cars from 50th Street on tracks which could be kept out of service only a few hours at a time. To remove 30-ton armatures in a limited number of minutes required exceptional skill.

The traction system of third-rail feeders, 36 in number, extended through a complicated system of ducts from the substation at 50th Street to various third-rail sections on both levels of the terminal. To lead them all to the new substation would require an expensive duct system and miles of cable. Therefore, a circuit-breaker house was constructed at 49th Street and all these cables connected to switchboard panels therein, but under distant control from 43rd Street. Twelve cables were connected between the 43rd Street substation and this circuit-breaker house.

These cables carry the average current to this 49th Street house, where it is subdivided among the various third-rail feeders. The electrical effect is the same as though the 50th Street substation had not been moved; but the relaying by miles of wires was eliminated.

Since the piping system of the terminal was laid out in a square with one corner near 50th Street, where steam, water, and air were introduced, and another corner near 43rd Street, it was decided to open these pipes at 43rd Street as a new feeding point and to close them at 50th Street, thus using the same pipes.

Existing masonry conduits were used, as far as possible, to contain the electric cables and supplement these by an overhead metal conduit system in existing trucking subways. It was necessary to install and support in an elevated position throughout the terminal, approximately 20 miles of 3½-inch steel conduits. Into these conduits and the existing masonry conduits, 35 miles of cables of large size were drawn. These are the lighting and traction feeders. In addition, several miles of high tension and control cables were installed. The conduits concealed in the floor of the substation have a total length of 25,000 feet. In each conduit, from one to 16 wires are installed.

The high-tension masonry bus is 175 feet long and is divided into five sections. Connecting to it are 36 high-tension oil switches. More than 70 tons of bar copper was used in the buses. This all had to be drilled, bent, insulated, and supported.

All this work was accomplished without any interruption to, or interference with, the normal operation of buildings, in the lighting or signal power supply, or in the traction current for the movement of trains. No traffic delay occurred in connection with the loading or unloading of apparatus, although such work took place on tracks in daily rush-hour service. Each unit of the new plant started operation on or ahead of schedule. No damage was done to any piece of apparatus during transfer. And during the entire intricate operation, which was completed at a cost of more than 3,000,000 dollars, not a single man was injured.

Warmed By Satan

An Engineer's Discussion of the Familiar Proposal to Derive Power from the Earth's Hot Interior

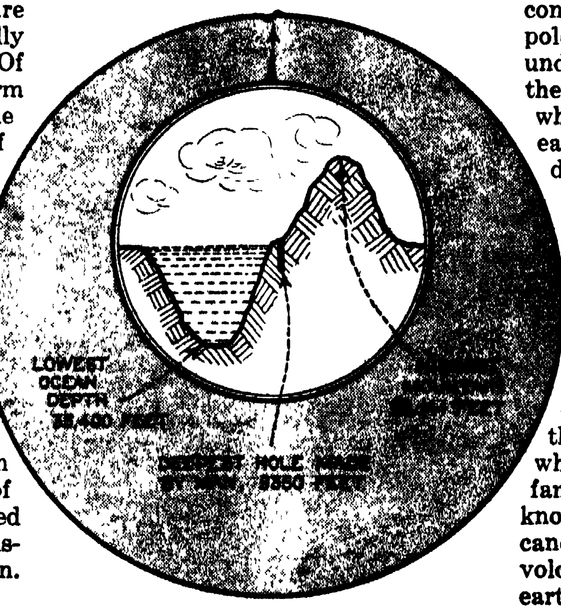
By THOMAS T. READ, E.M., Ph.D.*
Vinton Professor of Mining, Columbia University

THAT the interior of the earth is very hot is one of the things that people generally believe, without knowing anything about it. Primitive men needed no evidence other than volcanic outbreaks to convince them of it, but then the number of people who have ever seen a volcano at any time, much less one in eruption, must be very small indeed, and it is probable that the idea is one of those that the superstitious mind (and most of us are superstitious) has a natural tendency to believe. Millions of people believe that there is somewhere a place of everlasting fire where the wicked will be eternally punished for their sins on earth. Of course, such an idea originated in warm countries, where heat makes people uncomfortable. The primitives of the northland believed the place of eternal punishment was a cold place. The inside of the earth was a conveniently inaccessible place to assign as the locus of Sheol, Gehenna, Hades, or whatever the hot place was called.

Interest in Hell as a place of eternal punishment has generally waned and many people now feel that they catch enough Hell on earth, without expecting any more in the hereafter. Meanwhile the idea of a hot interior of the earth has received some scientific support from the discovery that the earth is cooling down.

OF recent years public attention has been stirred, every now and then, by someone's suggestion that since the interior of the earth is very hot, all we have to do is to find a way of bringing the heat to the surface and we will thereafter have a perpetual source of heat, without having to dig and burn coal. There is something peculiarly comforting in the thought that the presiding genius of the hot place, instead of being an evil spirit who will torture us forever, may really be a beneficient individual who will bless our descendants by freeing them from coal strikes and furnace tending, and it seems worth while to consider whether there is any more inherent probability in the new view than there was in the old one.

Why do we believe the interior of the earth is very hot? The distance from the outside of the earth to the center is about 21,000,000 feet and the deepest hole men have made into it is about 9350 feet or about 0.045 percent of the whole distance. But hold up, where is that measured from? From the top of the hole, of course. It does not require a very alert mind to see that a man who dug a hole in the bottom of a valley would be starting nearer the center of the earth than a man who dug a hole, starting on top of a hill. The deepest hole is Oscar Howard's No. 7 Hathaway well in the Sante Fe Spring Field in California, and it does not get as near the center of the earth as many "deeps" in the Pacific Ocean, for its reported depth in January was 9350 feet. The highest mountains stick up nearly six miles above mean sea level, and the deepest holes in the ocean bed are even deeper, so that the holes that men have been able to make are only about one quarter as deep as the holes Nature has made.



JUST A SCRATCH

The deepest place in the sea, exaggerated six times, is shown at the top of the outer circle representing the earth. In actual distance this place reaches only 1/620 of the distance to the earth's center

But men have made lots of holes several thousand feet deep; the total number of oil-wells in the world is somewhere near a half million, not to mention water wells and mines. I have myself been 6700 feet below the surface of the earth in the St. John del Rey mine in Brazil, which has since been deepened to over 7200 feet. Workings in South Africa are 7600 feet deep. As you go down in these holes you find the temperature rises as you descend. To make matters more difficult for us, the rate of increase is different in different places. In some it is as much as one degree Fahrenheit for every 60 feet in depth. In South Africa where there are many deep mines, the rate is only one degree for every 250 feet.

It is all very puzzling, for if the earth was uniformly hot all over hundreds of millions of years ago and has been cooling down ever since, it is evident that it ought to have cooled down faster near the poles, and the rate of increase as you go down there ought to be slower. No one has yet found it convenient to dig deep holes near the poles, so we do not know what it is like underground, but we do know that there are active volcanoes in Iceland where there ought not to be any if the earth has been cooling off for hundreds of millions of years. The only way to get around that is to suppose that relatively recent cracks in the earth's crust have let hot material come up from below, just as hot lava comes up in a volcanic outburst.

Explaining the mechanism of a volcano is much more difficult than explaining that of a radio set, for there are at least a thousand people who are interested in and somewhat familiar with radio, to every one who knows or cares anything about a volcano. The simplest way is to say that volcanoes are local hot spots on the earth's surface, much as a steam radiator is a local hot spot in a room. We know very well where the steam in a radiator comes from, but there are at least seven different hypotheses as to what makes lava melt. The one which nobody believes any longer is that the interior of the earth is molten, and that the lava comes up from below as steam does from the boiler in the cellar.

ALTOGETHER, figuring out that the interior of the earth is at a temperature of 7000 degrees, or 27,000 degrees, as various people have done, seems to me to be a good deal like the well known process by which a city dweller figures out, with pencil and paper, how he can get rich by raising chickens. The scientist calls the process extrapolation; you know the course of the line from A to B, and you simply prolong it to C. It is perfectly easy to prolong a straight line, but when the known points make a line that looks like the track made by a two-day old calf trying to get to the other side of the pasture, prolonging it is anybody's guess. Anyway, you always can say, if anybody denies your conclusions, that he can not prove it is not the way you say it is.

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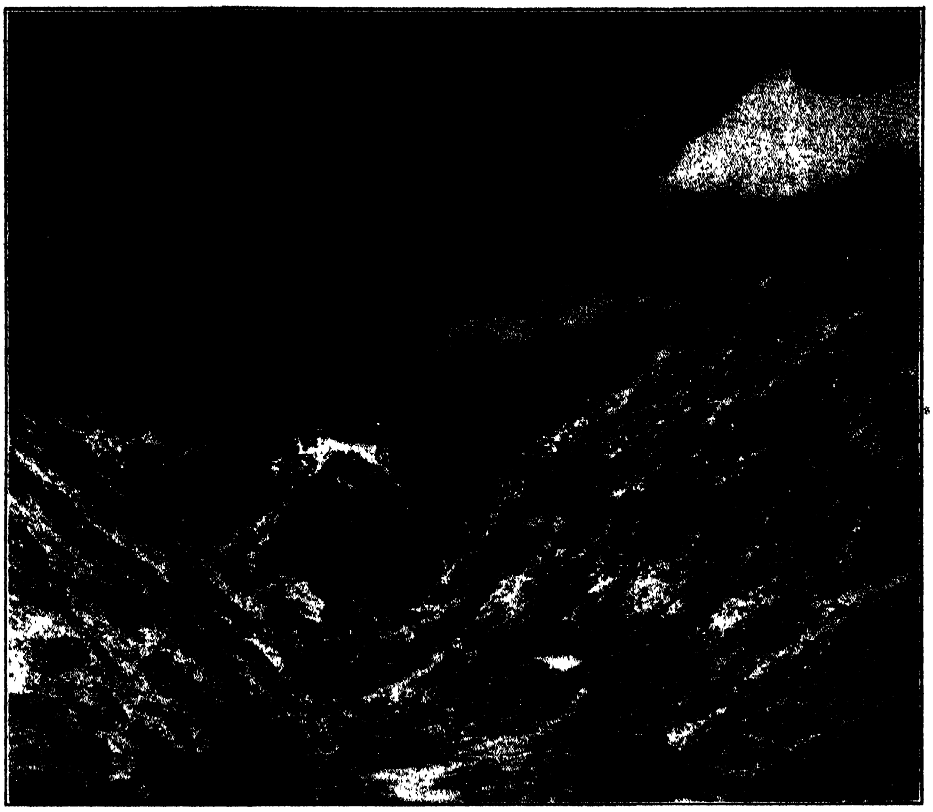
*See "Among Our Contributors," page 421

After all, it doesn't matter just how hot the interior of the earth is, as long as it is a good deal hotter than the outside, and everybody who knows the evidence of observations made can at least agree on that much.

The next question is, what of it? Everybody knows that Palm Beach is considerably warmer than Kennebunkport in January, but the only practicable way for a Kennebunkporter to benefit by it is to buy a ticket to Florida. The people who dream of having Satan for a janitor are pleasantly vague about it. They propose to dig holes anywhere from five to 25 times as deep as the deepest artificial holes yet made and somehow bring the heat up the hole.

Maybe the digging of the hole can be done. It costs from 75,000 to 150,000 dollars to dig a deep oil well and the deeper you go the more expensive it gets. A hole five miles deep probably could not be made at all with present methods and equipment, and even if it could no one could guess whether it would cost 5,000,000 or 50,000,000 dollars. Obviously we would have to have two holes, for if the water to make the steam went down an inner or outer tube in the same hole that the steam was coming up, the heat in the steam would go into the water. In fact, it is a very puzzling problem how, starting with steam at the bottom of a hole five miles deep, you could get it to the top without having it cool down and condense to water again. But maybe it could be done if the steam passed through the hole fast enough, for the rate at which the heat would leak away is so many heat units per minute and if the quantity of steam passing through is multiplied by ten the percentage of heat lost is reduced to one tenth. So let's say it can perhaps be done, and that we will trust inventive genius to find the way.



ONE OF THE EARTH'S "HOT SPOTS," THE GEYSERS, CALIFORNIA

Wells drilled into the warm ground at The Geysers, 60 miles north of San Francisco, give steam at high pressure. This thermal region has been studied scientifically by Dr. Arthur L. Day, Director of the Geophysical Laboratory of the Carnegie Institution of Washington and Dr. E. T. Allen of that Laboratory. This photograph, showing escaping steam, was taken by Dr. Day, as was the one on the cover of our number for November. Through an inadvertence having to do with editorial routine that fact was not then mentioned

ASSUMING that we can make a hole for the water to go down and another for the water to come up, the next question is, how to connect them at the bottom. The only reasonable answer is, I do not know. The boring of oil wells is done from the surface, but to make a hole five times as deep as the present deepest would probably involve getting down inside it, and since we are being so generous let us concede that perhaps people could somehow get to the bottom of the hole and make a cross passage. It is only a few years since nearly everybody was quite sure that men could never fly through the air, and it is decidedly risky to say anything cannot be done, merely because no one now knows how to do it.

But here another question troubles us. How would we keep the hole open, even if we could make it? Everybody knows that in making the tunnels under the North and East Rivers, in New York, much engineering skill is required to guard against the pressure forcing the soft materials of the river bottom into the hole that is being made. At these shallow depths the pressures are such that compressed air, cast iron rings, and concrete are able to cope with them, but when we talk about depths of five miles, or 25 miles, we are in a region of immensely greater pressures. From laboratory experiments Professor Adams, of McGill University, concluded that holes could exist in solid granite at a depth of 11 miles. Whether they could exist at twice that depth is extremely doubtful; where the rock is not solid much difficulty is experienced in keeping the holes open in ordinary mines.

Finally, there are those inexorable things, the laws of thermodynamics. Lest the reader hastily turn over the page, let me say at once that I am not going to tell what they are. Everyone knows that you can not cook eggs on top of mountains, because the water boils at too low a temperature to cook the eggs. The reason is, that the lowered pressure lowers the boiling point. So it is easy to understand that raising the pressure raises the boiling point, but the interesting thing is that it finally gets to the point where you can not boil it at all. Perhaps it would be better to say that at such high pressures and temperatures no one can say whether you would have water or steam. If a hole five miles deep were filled with water flowing down it, to come up the other hole as steam, the pressure at the bottom would be about 11,500 pounds per square inch and the temperature, on the basis of one degree for every 200 feet, would be 130 degrees above what it started down at, or say 200 degrees. This is below the boiling point at surface pressure. The critical pressure of water is about 3000 pounds per square inch; at that pressure it boils at 690° Fahrenheit, and above that pressure no increase in temperature would make it boil. Since the pressure at the bottom of the hole would be nearly four times the critical pressure, even the heat of an oxy-acetylene blowpipe would not suffice to make it boil there. But this difficulty could be met by letting the water, after it had descended a limited distance, discharge into an open catch basin, and so go on down, arriving at the bottom at a pressure corresponding to the last drop, or 438 pounds to the square inch for a drop of 1000 feet. At this pressure a temperature of 450° Fahrenheit would suffice to make it boil.

Of course it is not necessary that the

water should boil at the bottom of the hole, but what we are after is heat, and a pound of water raised 130° Fahrenheit in temperature has taken on 130 heat units, while a pound of water that has been converted into steam 130° Fahrenheit above its initial temperature (whatever that was), has taken on 1102 units. Because of the greater heat-transporting power, therefore, we should much prefer to bring the heat up in steam. Let us see whether there is any chance that we could do this.

ANOTHER WELL KNOWN HOT SPOT—IN ITALY

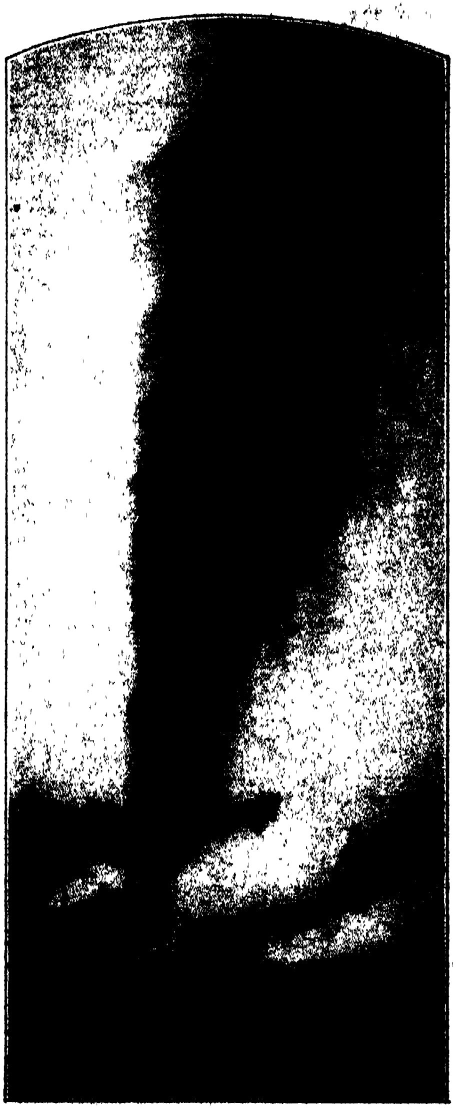
Steam escaping from thermal region at Lardarello in Tuscany. Here several thousand horsepower of energy have actually been developed but, as the author states, these thermal areas are not a promising source of vast energy such as the world needs to keep the wheels moving

Suppose that at the place where we are trying to get heat from the depths the rate of temperature is 1° Fahrenheit for every 100 feet; which certainly is the upper limit, according to the bore-hole records. At this rate the temperature at 26,000 feet would be 320° Fahrenheit, or that inside an ordinary steam boiler which is working at 75 pounds pressure per square inch. By cutting our last drop down to a little less than 200 feet we could reduce the water pressure to 75 pounds and, after all this trouble and expense, we would have——a set-up as practicable as an ordinary cheap coal-fired boiler; with the sole advantage that we would not use any coal in it, if—and there is a big "if"—we could get the heat out of the rock into the water.

The cause of that "if" is that rock is, as geologists know, not much better as a conductor of heat than the protective coverings that are put on steam pipes to keep them from losing their heat. The first few pounds of water would cool the surface of the rock, and the heat would have to pass through the rock by conduction and this rate is exceedingly slow even where considerable differences of temperature exist between T_1 and T_2—the respective temperatures of the two working substances. Perhaps a Jules Verne could imagine some way in which the water could be made to pass out through channels to great distances from the bottom of the hole, finally returning to the bottom of the other hole to emerge as steam, but my own fancy is unequal to the task. Engineers naturally hesitate to say that anything can not be done, but they may say they can not imagine any way of doing it, with present knowledge.

Someone will here say that there must be something wrong somewhere, because he has seen natural steam coming out of the ground in Yellowstone Park and has read that there are numerous other places where steam escapes, while hot springs are even more common. There are many of these local hot spots on the earth's surface and the scientists do not know how they get that way. Many explanations have been offered; such as that by earth movement molten rock has been brought up from below to near the surface and that the steam represents either surface water that has been heated by coming into contact with the hot mass, or else that it is water vapor that was in the molten material and is now escaping from it. There are difficulties in all these explanations, and we may here accept the two facts that over most of the earth's surface the rate of increase of temperature as we go down is too slow to offer hope of practically drawing heat from the interior of the earth, and that at some places there are local hot spots at which steam issues at the surface.

Suppose, then, that we forget about the rest of the earth and concentrate on the hot spots. There we have what Kipling would call "another story," one that I shall not attempt to outline here![1] Suffice it to say that the "steam" is not just steam, but contains a good deal of uncondensible gas and also, usually, chemicals that make it impracticable to use it directly in a steam engine, so some of the attempts that have been made to utilize it depend on using the "steam" to heat water and make ordinary steam that can be used in an engine. Add to this the fact that these hot spots are usually at places where there is nobody nearby who is a consumer of power and you arrive at something like the familiar water-power problem of having a source of power but the cost of harnessing it for utilization makes it cost more than power from coal.[2]



NOT AN OIL GUSHER

The eruption of a large steam well drilled in the thermal soil of a small area in Italy

THE conclusion therefore is that coal producers need not lie awake nights worrying over the possibility of having their markets invaded by heat drawn from the interior of the earth.

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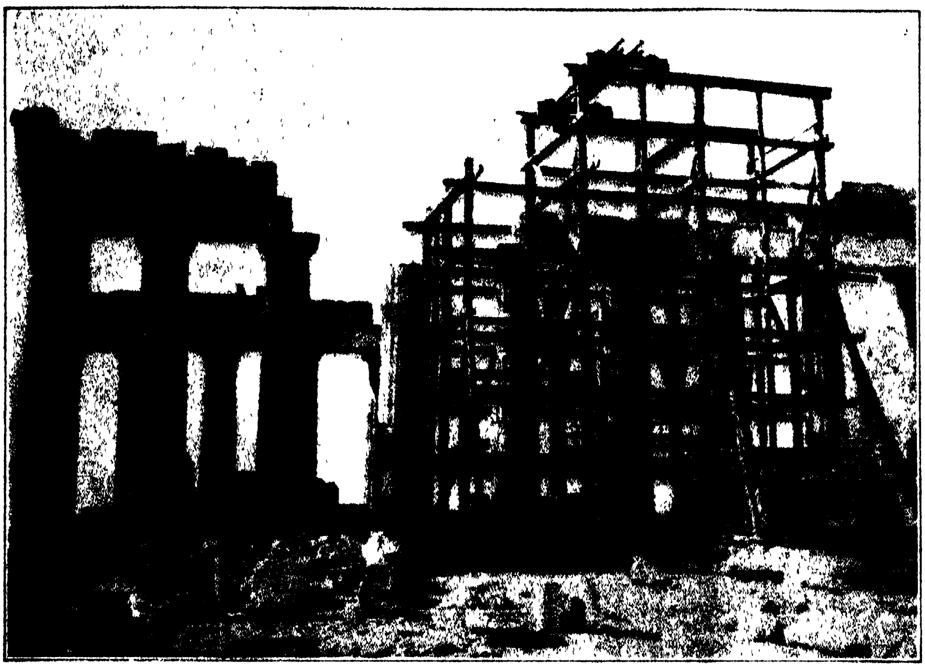
[1] See "Power from the Earth," describing one such development in Italy, SCIENTIFIC AMERICAN, November, 1929, pages 422-424—Ed.

[2] See discussion of various power sources of the future, SCIENTIFIC AMERICAN, February, 1930, pages 141-145—Ed.

From the Archeologists' Note Book



REPAIRING THE PARTHENON

The drums of the columns of the 5th Century B.C. Parthenon at Athens are being placed in their original position, having been thrown down in 1687 during the siege of that city

Digging up Athens' Broadway

AMERICAN scholarships and American dollars have combined to excavate the *Agora* or market-place and forum of ancient Athens. This might be likened to the Broadway or Fifth Avenue of the antique city of culture. The cost will run into millions and it will require ten years to make the excavation in an orderly manner. Prof. J. Leslie Shear of Princeton University will direct the work. The Greek Parliament has passed a special law by which the American archeologists may condemn the houses by properly compensating the owners. The scientific enterprise is backed by over 40 universities and colleges of the United States. The buildings which now occupy the site are squalid and unimportant.

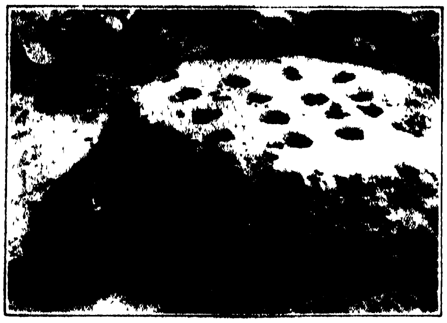
The *Agora* was the heart of Athens—commercially and socially. Here we had shops, markets, studios, and forums for discussions of all kinds. Here Apelles exhibited his paintings and here occurred the memorable meeting of Diogenes and Alexander the Great. Trading was carried on to a considerable extent, for Athens was a great center for luxurious merchandise. Trial by jury was also inaugurated here and we can almost see the reluctant potential jurors of yore trying to get excused from duty.

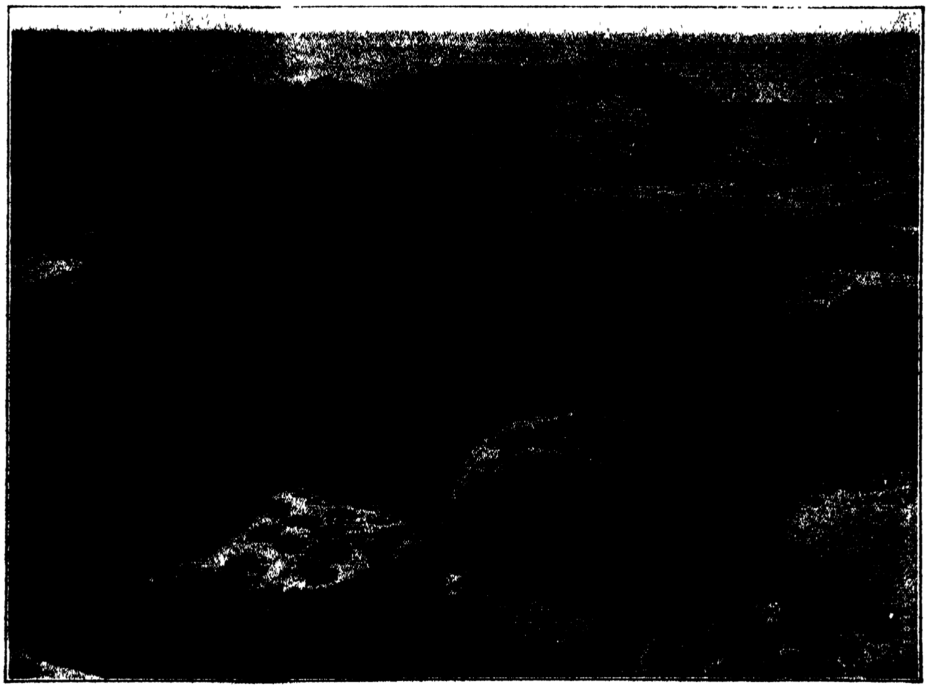
There are so many references to the *Agora* in classical literature that the task of the archeologists is much simplified. The excavated regions will be transformed into a park, as far as the maintenance of the antiquities permits. The site is the most promising in all Greece and the finds will probably be very important. When the excavations shall have been completed we can visualize the Athens of Socrates and Plato, as well as that of the dandies and revelers, for all sorts and conditions of men foregathered here.

Our illustration shows the repair rather than restoration of the Parthenon. This is not a part of the *Agora* plan but is a necessary although belated attempt to salvage one of the world's most precious structures.

An Ancient Bakery

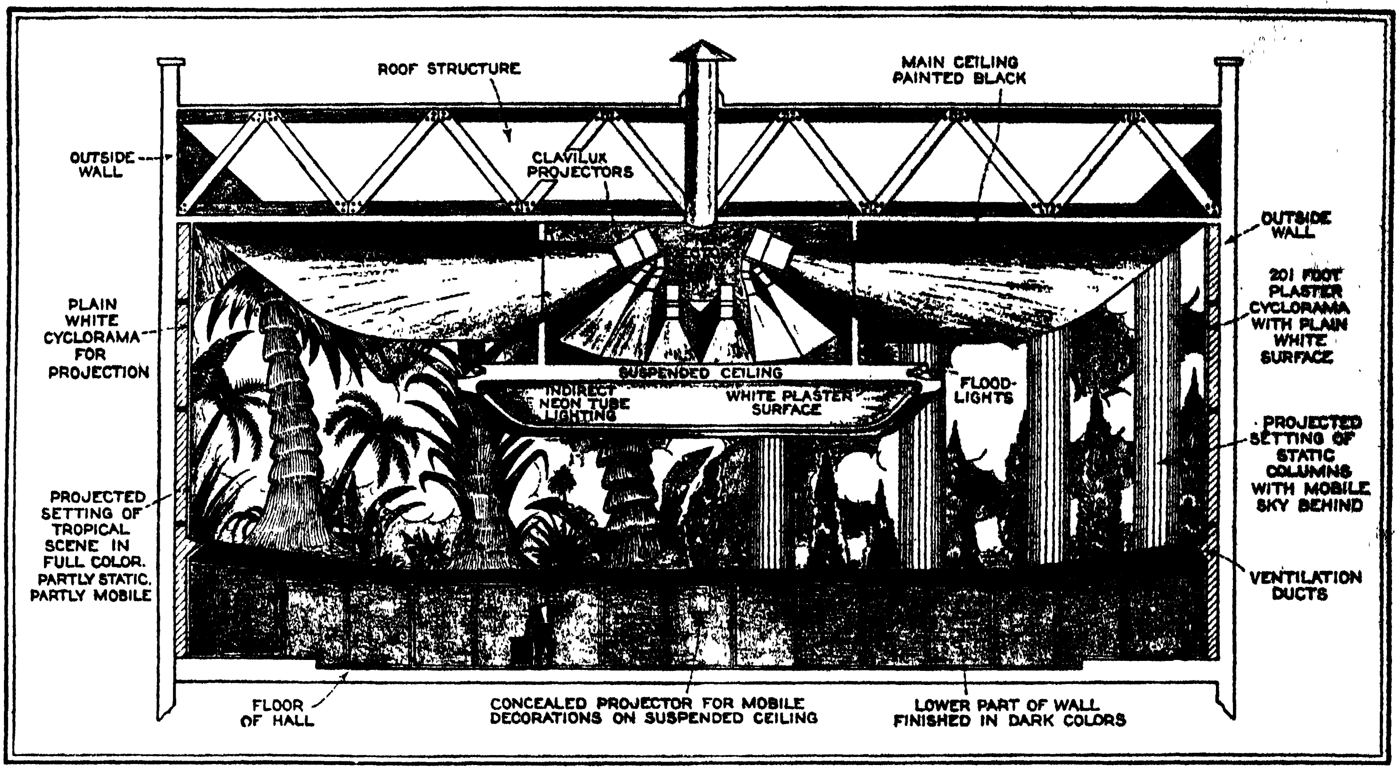
THE remains of what is believed to have been the earliest bakery established by any civilized people were found recently by the Field Museum-Oxford University Joint Expedition to Mesopotamia on the site of the ancient city of Jemdet Nasr. The bakery consists of a group of clay ovens, estimated to have been built about 4000 B.C., according to Mr. Henry Field, assistant curator of physical anthropology at the Field Museum of Natural History. The ovens consist of large clay mounds, hollowed out inside, and with holes through the top to permit the passage of heat. At their bases are fire holes large enough for a man to crawl into. Huge piles of cinders of ancient fires were found inside. Pots and pans containing the bread to be baked were placed on the tops of the ovens, where the heat reached them through the holes.





THE OLDEST BAKERY IN THE WORLD

Remains of clay ovens discovered in Mesopotamia at the ancient city of Jemdet Nasr by the Field Museum-Oxford University Joint Expedition. *Above:* an Arab in the fire hole


ROOF STRUCTURE
MAIN CEILING PAINTED BLACK
OUTSIDE WALL
CLAVILUX PROJECTORS
OUTSIDE WALL
201 FOOT PLASTER CYCLORAMA WITH PLAIN WHITE SURFACE
PLAIN WHITE CYCLORAMA FOR PROJECTION
SUSPENDED CEILING
INDIRECT NEON TUBE LIGHTING
WHITE PLASTER SURFACE
FLOOD-LIGHTS
PROJECTED SETTING OF STATIC COLUMNS WITH MOBILE SKY BEHIND
PROJECTED SETTING OF TROPICAL SCENE IN FULL COLOR. PARTLY STATIC. PARTLY MOBILE
VENTILATION DUCTS
FLOOR OF HALL
CONCEALED PROJECTOR FOR MOBILE DECORATIONS ON SUSPENDED CEILING
LOWER PART OF WALL FINISHED IN DARK COLORS

A HUNDRED HALLS IN ONE

In the ballroom of the Hotel Sherman at Chicago the new art of light has found one of its practical applications. Here all the decorations are projected from a suspended chamber

Light Furnishes Ballroom Decorations

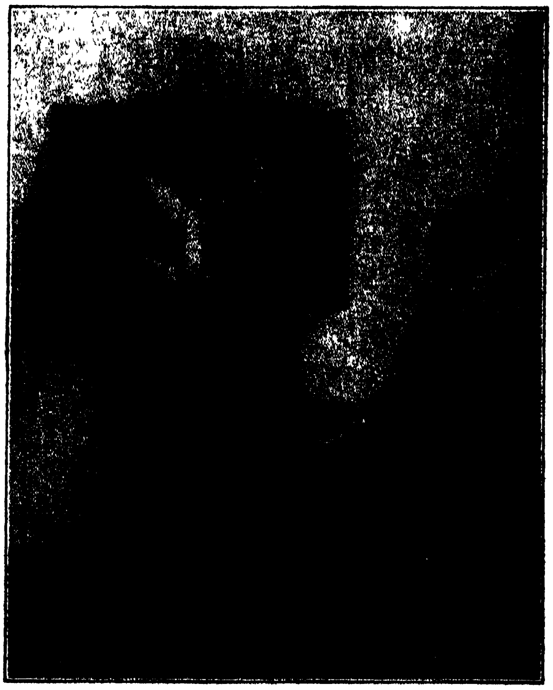
Color-Harmony Introduces a New Mode of Expression

SINCE Bainbridge Bishop patented his "color organ" in 1877, many artists and inventors have been at work on the creation of an art form of light somewhat similar to the age-old art form of sound-music. In its early stages this pioneer work was greatly hampered by the unfortunate and totally unfounded belief that each color corresponded definitely to a musical note. Now, however, the light artists of later years have come to look at light as an independent medium for esthetic expression no more related to music than to painting or sculpture. Form, color, and motion are the basic factors, according to the theory of Mr. Thomas Wilfred, an artist in light who has developed his dreams into the practical applications which we illustrate in this article. He has designed a clever keyboard from which lighting of any kind can be controlled with such delicacy as to enable an artist to express himself in form, color, and motion.

The Hotel Sherman in Chicago, wanted a mobile decoration for their ballroom—one that would be flexible enough to allow rapid changes to be made for varied functions. The hall may thus be used for a piano recital in the setting of a Grecian Court: For the Rotary Club luncheon the turning wheels, their well-known emblem, would be appropriate: For a woman's club tea in the afternoon, it can be decorated by diaphanous moving forms of a purely abstract nature: At night it can be turned into a Persian garden, slowly changing and opening vistas of enchanting beauty.

Our first illustration shows the means by which this is accomplished. The ballroom is finished in plain white plaster without a trace of decoration, which is all to be provided solely by means of light projection. The decorations are filed like phonograph records and are instantly available. The suspended projection chamber takes the place of a portion of the ceiling proper and carries its own ceiling below. This ceiling in turn is also decorated by projected mobile forms which issue from concealed wall instruments. Huge projection instruments in a semicircle are directed toward every point of the white walls. Below in a small chamber is the keyboard from which the operator commands a view of the entire hall. No operators are required in the projection chamber as the keyboard controls the light effects. The projection chamber is surrounded by a runway from which dancers can produce moving shadows of themselves on the walls.

To enhance further the projector images, a flood-lighting system is installed in the edge of the runway and an indirect neon-tube system furnishes



SUPERSEDING THE FIRE-PLACE

An instrument which plays form and color as a phonograph plays music. Colored disks are used light on the suspended ceiling. The true ceiling is not seen, as it is painted black and no light is projected on it, which would differentiate it from the false or suspended ceiling. The effect is that of a vast cyclorama, but the true surface is entirely obliterated by means of the three-dimensional projecting system used. The illusion of three dimensions is achieved by utilizing a new principle of optics. One of the effects which can be obtained, for example, is a tropical forest. Through the spaces between huge tree trunks can be seen vistas of tropical undergrowth, flowers, sky, and water, constantly moving and changing in form and color. A cathedral with sunlight streaming in through a number of stained glass windows is another possibility. Using pure decoration, the entire hall may be covered with abstract forms apparently in three dimensions, rhythmically advancing and receding. Or there may be a modern city with a semi-abstract treatment of towers, cranes, girders, and bridges, swinging and moving. Or, at the operator's fancy, there can be an oriental fantasy suggesting the "thousand and one nights" with movements of festoons of large jewels among minarets and crystal towers.

PROJECTORS

Twenty-three projectors in the suspended chamber cover the walls with unbroken images which are changeable at will

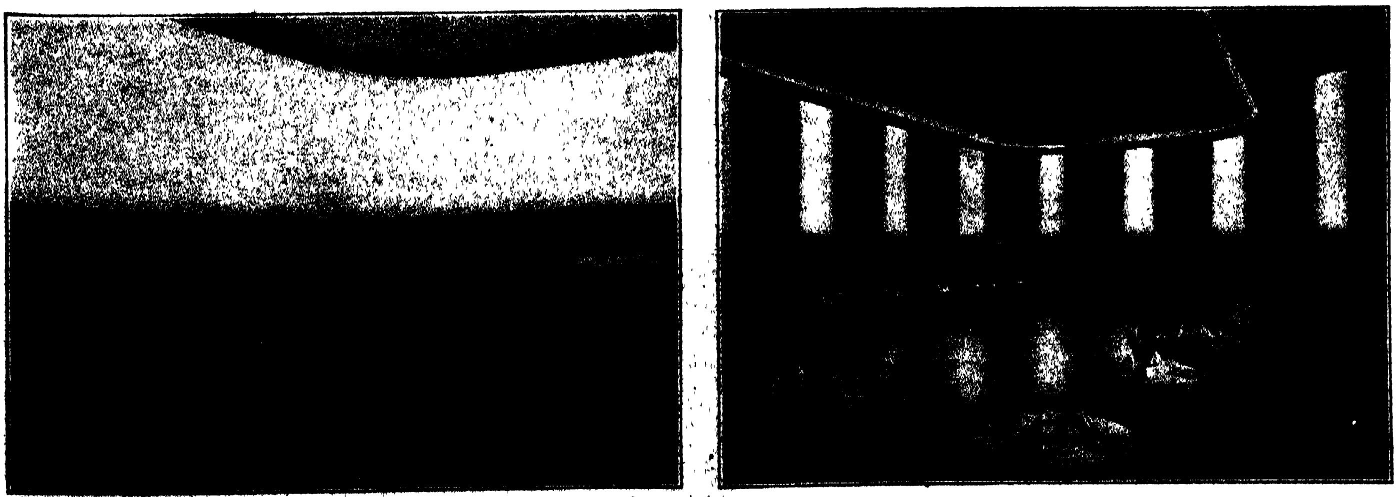
MUCH poetry has been inspired by the fire-place of yore, which has now been largely replaced by the uninspiring steam radiator or the unconvincing gas-log. The charms of story telling around the fire is as extinct as the dodo and the electric bulb has inspired no poetic muse. However, we may now take the very bulb and make it speak eloquently of the "stuff that dreams are made of" by a new instrument for home use. All one does is to open the doors which mask a curved screen, select a record from the drawer, take the tiny keyboard in his lap and the world of make-believe is his. Colored glass records rotating at different speeds are used to allow the lights to be projected onto a screen background lighted from above with the three primary colors from minature floodlights controlled by the player. Eleven buttons enable the player to modify the forms and colors projected through the slowly moving record to increase or decrease the tempo at will, or "freeze" any transitory form which appeals to the fancy, as long as desired.

THE LIGHT KEYBOARD

All projected images, colors, and movements are controlled by means of tiny keys sliding in grooves. This enables a recital to be given by a color artist

These cabinets can be designed to fit the architectural or decorative scheme of the room. They take up no more space than the modern phonograph or radio set. They are self-contained and all you need is to connect to an outlet, as with any other electrical device. The effect when seen for the first time is remarkable. You can give a home "color recital" with it.

With our noise-racked nerves, it would seem logical to seek recreation through silent beauty. We might even visualize, with Mr. Wilfred, large temples of light where people can find a place of silence with light as the only language of beauty.



"BEFORE AND AFTER"

At the left is seen the ballroom with light decoration omitted and all control keys at zero. Only a blank wall is seen. At the right the projectors are functioning and we have a Grecian court with three-dimensional fluted columns with night sky between

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Individual Hothouses for Plants

A NEWLY developed paper cover for plants, in effect a miniature hothouse for each plant, is coming into widespread use in some parts of the country. These paper covers, called "Hotkaps," are in the form of cones made of specially prepared waxed paper about 11 inches in diameter at the base. When placed over the plants, it is claimed that they protect fully against late frosts, wind, insects, and heavy rains.

Individual "hothouses" for plants being placed by means of the metal setter. The pre-formed paper caps fit snugly into this special device

The paper cones are inserted in a setter made of metal in the exact shape of the Hotkaps and the setter then placed on the ground over the seed or plant which is to be protected. Slight pressure on the handle of the setter forces the Hotkap into the ground a distance of ¼ to ½ inch. The edge of the paper cone which protrudes from under the edge of the setter is then heaped with soil, the setter is removed, and the paper is permanently in place. After the seeds have germinated and obtained a good start, a slit is cut in the side for ventilation; and later the top is cut out for the plant to grow through.

It is claimed that Hotkaps force a much earlier growth than would be possible under ordinary circumstances.

General Electric's Foreign Interests Gain

THAT the General Electric Company in the future will derive a greater proportion of its income from sources other than operations is evident from the substantial increase in its investments in associated companies, both in this country and abroad.

The greatest gain in such investments last year was in leading European companies, in some of which the General Electric Company, through International General Electric Company, previously had stock interests.

As a result of these acquisitions, investments of International General Electric Company at 74,665,063 dollars December 31, last, showed an increase of more than 100 percent over the total a year previously —35,418,307 dollars—funds for such investments being advanced by the General Electric Company.

General Electric retains intact its holdings of 1,240,530 shares of common of Radio Corporation of America, and these, too, are included, at conservative values, in the investments in associated companies, as well as additional capital supplied in 1929 to Electrical Securities Corporation and United Electric Securities Company to finance normal expansion of the latter's operations.

Income from investments in associated companies and miscellaneous securities, the latter being comparatively small, has been increasing each year for the General Electric Company and in 1929 represented 45 percent of all "other income." Against a total net of 67,289,880 dollars; including that from operations and other income, in 1929, total "other income" represented 31.8 percent.

The 9,681,387 dollars interest and dividends received from associated companies and miscellaneous securities in 1929 represented 6.6 percent of average value at which these investments were carried on the books of General Electric at the beginning and end of the year. It compares with a 7.6 percent return in 1928.

If the General Electric's proportion of undistributed earnings available for dividends of associated companies had been taken into income, the increase in total net would have been approximately $1.74 a share on the 7,211,482 no-par common shares outstanding at the close of 1929, bringing the per-share figure to $10.71, against the $8.97 that was reported.

Considering undistributed equities and various other items, the nearest calculation of share earnings would be around 13 dollars on the common, or an increase of more than 40 percent above reported figure. Total net, on this basis, would be in excess of 90,000,000 dollars, whereas actual reported income was 67,289,880 dollars.—*Barron's.*

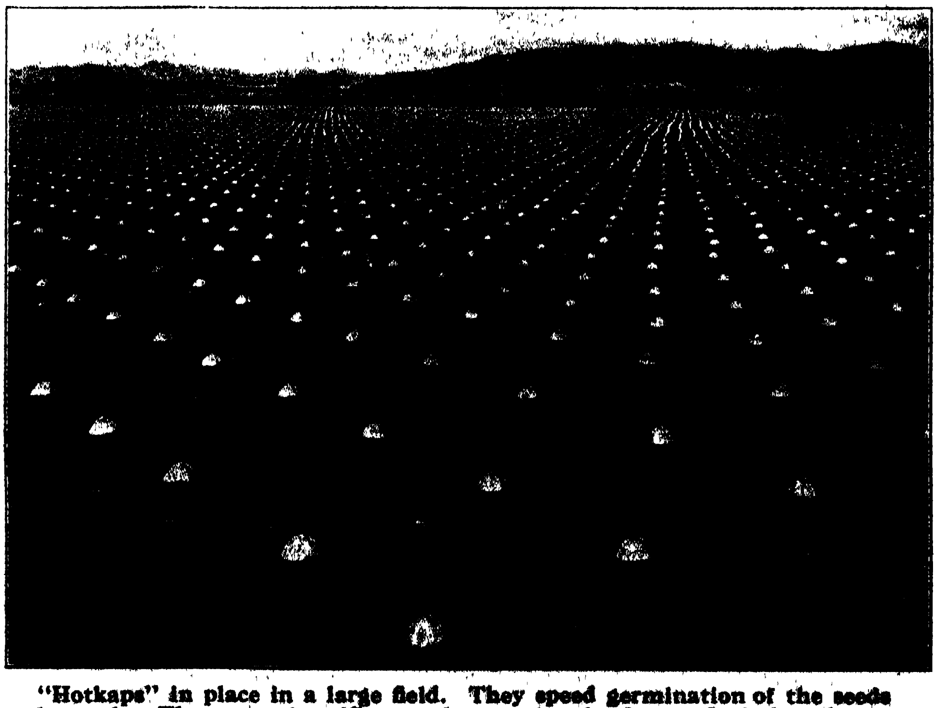
New Rubber Plants in the United States

RUBBER plants, of a species so productive that it has been exploited almost to the point of extinction in its native home in Madagascar, are now growing in southern California and Florida and have withstood the climate during the past winter with no apparent damage. So far only a few plants have been established but this number will be increased as rapidly as possible.

These rubber plants belong to the species *Euphorbia intisy*, and were brought to the United States more than a year ago by Dr. Charles F. Swingle, botanist of the United States Department of Agriculture, who spent several months on a plant exploration trip in Madagascar with Professor Henri Humbert of the University of Algiers.

Intisy is a shrub or small tree reported to reach a height of approximately 20 feet, although no specimens of this height are known to exist at this time. The trees are leafless, and present a scraggly appearance. Their ability to grow in the very dry regions of southern Madagascar is accounted for by an unusual root structure. The roots resemble links of sausage, and act as reservoirs for water.

With the discovery of this plant in



"Hotkaps" in place in a large field. They speed germination of the seeds beneath. The paper is stiff enough to resist the force of wind and rain

Madagascar in 1891, commercial exploitation followed at once, and annual rubber exportation jumped from less than 50,000 pounds to almost a million pounds. The ruthless exploitation soon showed its effect, reports Doctor Swingle, in an article in the *Journal of Agricultural Research*, and within a few years *intisy* had become so rare that observers reported it was very difficult to find specimens.

In some of the regions where Doctor Swingle found *intisy* growing there are periods of six years at a time when there is no rain.

"The manner of obtaining *intisy* rubber," Doctor Swingle says, "is very simple and is one of the factors that led to the commercial disappearance of this plant. The latex, which flows from any cut, coagulates in the air without further treatment. All that the native has to do is to make cuts in the stem, return in a few days and pull off bands of rubber of very high quality, especially desirable for the manufacture of automobile tires.

"The yield of rubber from stems less than one inch in diameter is so slight that it does not pay to tap them. However, during the time of commercial exploitation, spiral cuts were made all the way up the tree, and yields of 15 pounds or more of rubber would be obtained from a single tree. In many cases the first tapping was so severe that the tree died outright."

Two-Way Television Demonstrated

TELEVISION has taken another step in its development, with the production of an experimental system of two-way television supplemented by the usual two-way telephone, permitting the parties to a conversation to see as well as to hear each other.

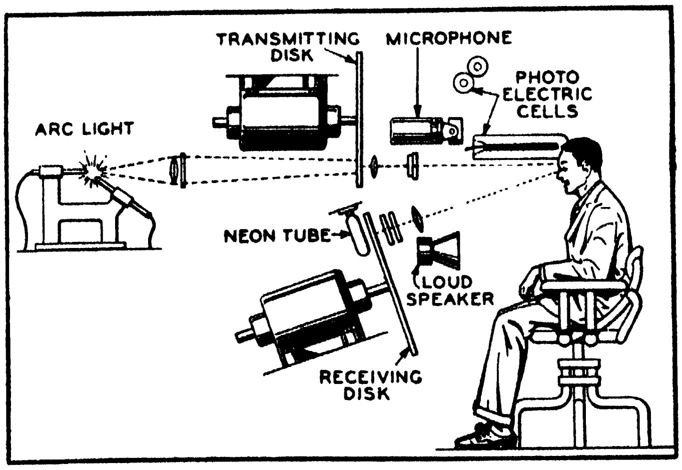
An experimental service between the American Telephone and Telegraph Company's building at 195 Broadway and Bell Telephone Laboratories at 463 West Street, which has been in operation for some time, was disclosed recently to the editors of this magazine. Special telephone-television booths were installed at these two buildings.

In one of these booths a person seats himself before a frame in which he will see the face of the person with whom he is talking. His own face is rapidly scanned by a mild beam of blue light which reflects from his face to the photoelectric cells and gives rise to the current which transmits his image to the distant booth. There is no fierce glare to the scanning beam; and one is not annoyed by its presence and may even gaze directly at it without inconvenience.

One of the two-way television cabinets. On the small "screen" in the center, one sees the person at the distant end; and above this is the scanning-beam hole

The first thing which strikes the observer when he steps into the booth—which is lighted with a dim orange light to which the photo-electric cells are insensitive— is the absence of the usual telephone. Special telephone transmitters and receivers are concealed in the booths. One talks face to face to the distant person and a hidden receiver speaks the words which seem to issue from his mouth. The other party to the television-telephone conversation appears with sufficient detail for recognition of facial expression.

The television image is greatly improved over that originally demonstrated by Bell Telephone Laboratories in 1927, and is about twice as large with a corresponding increase in detail. The image, which has the detail of about five thousand discrete points of light, is formed 18 times a second. The photo-electric cells, used in picking up the face which is to be transmitted, have been much improved in sensitiveness and give rise to about 10 times the current for the same amount of light as did those developed for the earlier demonstration. This increased sensitivity and the use of the blue scanning beam have made possible the reduction of the dazzle and glare which occurred to a certain extent in the earlier forms of apparatus. The increased area and detail of the image necessitate the use of a transmitting band of 40 kilocycles.



At right: **Arrangement of apparatus in two-way television. As the incoming image is viewed through the lower scanning disk, the speaker's face is scanned by the upper disk. A microphone and loudspeaker complete the layout**

At left: **Opened doors of the three major cabinets of the television-telephone apparatus show photo-electric cells at right, scanning disks for receiving and sending in the center and the arc-light for sending at left**

New Inexpensive Eight-inch Fan

THE Westinghouse Electric and Manufacturing Company has recently announced a new eight-inch fan of the non-oscillating type in the price-range of five-inch fans now on the market. It is a portable type, the body being made of cast iron in an attractive black finish, the fan blades are heavy gage sheet steel, and the guard is of heavy steel wire. It is single speed and is controlled by an on-and-off switch in the base.

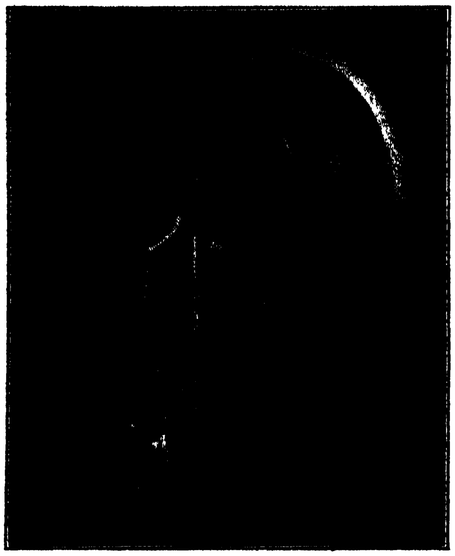
Wasteful America Saves Billion in Scrap Annually

EVEN if Americans are wasteful, as is often claimed, they salvage nearly a billion dollars' worth of their waste every year. This is according to figures of the United States Bureau of Mines on the amount of scrap and secondary metal recovered, which is increasing every year.

The waste trade industry is concentrating in large units. Even gold and silver is recovered in quantity from jewelry and dental waste. Photographic solutions contain half an ounce of silver to the gallon and 1,000,000 feet of waste movie film yield 800 ounces.

Of the 500,000 tons of secondary copper recovered annually, part comes from 300,000 burned out electric lamps collected by one company. About 40 percent of the annual supply of tin and lead has been used before.

The iron and steel saved in a year is worth 500,000,000 dollars. Other metals



Rear view of the small air conditioner showing all of its parts

salvaged in quantity from scrap, sweepings, skimmings, and dross are mercury, zinc, antimony, aluminum, and nickel.—*Science Service.*

A Home-Size Air Conditioner

FOR reasons of health and personal comfort, stress has recently been placed upon the necessity for purifying and cooling the air in which we live and work, in home, office, and factory, but most attempts to solve the problem have resulted in the production of the elaborate air washing and refrigerating equipment now commonly used in theaters and, in a few cases, in office buildings. Recently, however, a compact air washer-cooler-ventilator which can be used for small offices or even in the home was developed by John H. Fedeler, Building Superintendent of the New York Public Library.

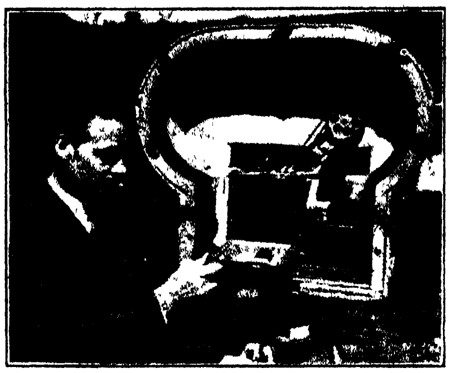
Mr. Fedeler first realized the necessity for such a device when he worked, in 1895, as a draftsman for Mr. Edison at the ore mines in Edison, New Jersey. When the crushing plants at the mines were in operation, he noticed that the whole countryside was enveloped with a dense dust cloud. He later conceived the idea for the unit which he finally developed, but many experiments lasting over a period of 30 years, and the expenditure of thousands of dollars were necessary before he attained his goal.

The complete machine is shown on this page. Its parts are: a circular brush, the "bristles" of which are of crimped Monel metal wire; a scientifically shaped casing of light-weight metal; an electric motor; a small water pump together with necessary tubing of metal and rubber; and a water box or tank on which the other equipment is mounted. As the motor rotates the brush at a speed of 1500 or 2000 revolutions per minute, the pump, which is also run by the motor, draws water from the tank and throws it into the brush. Due to the shape of the casing, air is drawn in and as it comes in contact with the wet brush, dust and dirt in the air are captured by the water and thrown by centrifugal force to the casing. The constant flow of water carries the dirt down into the tank where it settles out and may be removed periodically. The air also is thrown by centrifugal force to the casing and, because of the shape of the latter, is deflected through the unit into the room beyond. The rapid evaporation of water in the current of air causes the temperature to be appreciably lowered and a partial adjustment of humidity.

When desirable, a small amount of perfume may be added to the water used, so that the air will be perfumed. Also, when the air of any locality has been found to be acid, a neutralizing alkali such as ammonia may be dissolved in the water.

Feeding Helps Sick Trees

A RECENT development in the care of shade trees is the importance now given to "feeding" a sick tree before a lot of tree surgery work is attempted. Workers in the United States Department of Agriculture explain that this does not mean that pruning and other surgical work is not necessary, but if a tree is not vigorous, an application of plant food is likely to prove very helpful in restoring the tree to a healthy condition. Fertilizers which give immediate effect include nitrate of soda and sulfate of ammonia, applied broadcast in the spring or early summer at the rate of two to five pounds for a medium-sized tree.



Lane Chandler, movie operator, is shown with the "blimp" camera cell he has devised. By enclosing the camera in this padded cell, all clicking is kept from the microphones while making "talkies"

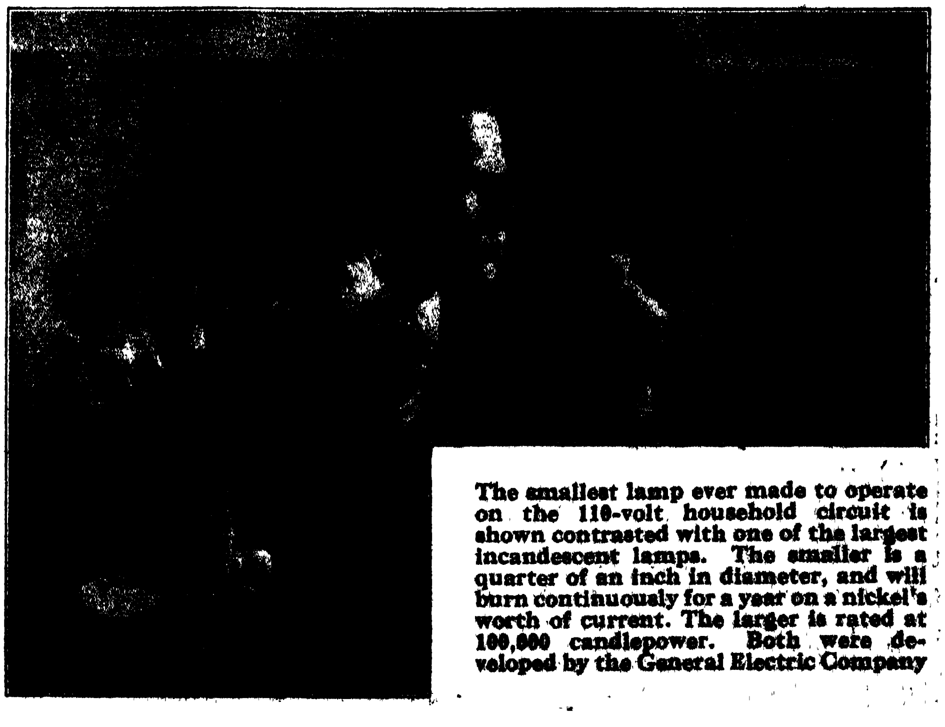
The direct effect of such an application usually lasts for only a year, but the indirect effect may be apparent the following year, as it usually stimulates the healing of wounds made by pruning or cavity work. An excess amount of fertilizer or an application late in the season may cause injury by stimulating excessive development of foliage and failure to mature the new wood properly before winter sets in.

Centennial of the Modern Scale

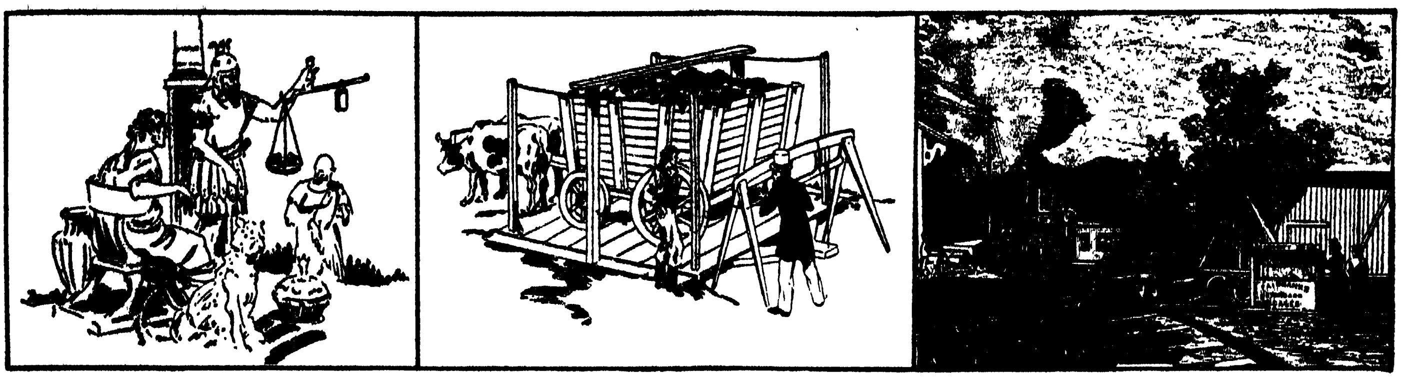
MANUFACTURING methods of today are concerned chiefly with mass production and the waste both of time and materials. It naturally follows that accurate weighing plays an important part in almost every phase of the production schedule. Thus it is that the year 1930, marking the centennial of the platform scale, is particularly interesting in that it shows what may come out of small beginnings.

From the steelyard of ancient days, there was no improvement in methods of weighing until, in 1830, Thaddeus Fairbanks invented the platform scale, the prototype of all modern scales.

It was in 1815 that Major Joseph Fairbanks moved from Brimfield, Mass., to St. Johnsbury, Vermont, and set up a grist mill and saw mill on the banks of a little creek that ran through this old Vermont town. His sons, Erastus and Thaddeus, had even broader visions and established a wheelwright and foundry business and then developed the manufacturing of saws, pitchforks, cast-iron plows, and stoves. In about the year 1830 the "hemp craze," as it was called, struck Vermont and the farmers expected to make substantial fortunes in raising hemp instead of corn. Contracts for making hemp-dressing machines were awarded to the Fairbanks brothers. The question now arose—How was the hemp to be weighed? The old steelyard was of little use for this service and so Thaddeus conceived the idea of constructing a huge steelyard beam suspended from a high frame with chains to grapple the axle of the cart. An approximate weight was thereby obtained by a process that was both slow and laborious.



The smallest lamp ever made to operate on the 110-volt household circuit is shown contrasted with one of the largest incandescent lamps. The smaller is a quarter of an inch in diameter, and will burn continuously for a year on a nickel's worth of current. The larger is rated at 100,000 candlepower. Both were developed by the General Electric Company



Evolution of the modern scale. At the left is shown the steelyard which was used by man from early times until Fairbanks invented the platform scale. Fairbanks' scale, in center, was the prototype of the one at right

Thaddeus studied the problem and finally conceived the idea of supporting the platform upon an A-shaped lever with the tip of the lever connected to the steelyard by a rod. Though not suspected by Thaddeus at the time, he had revolutionized all weighing methods and at that moment the steelyard of old Rome took its departure.

From this small beginning the platform scale in all of its ramifications was developed until today the same principle is in use, whether in a health scale, a laundry scale, or the ponderous ones used for weighing the largest railway locomotives.

Pump Dry Cement Across River

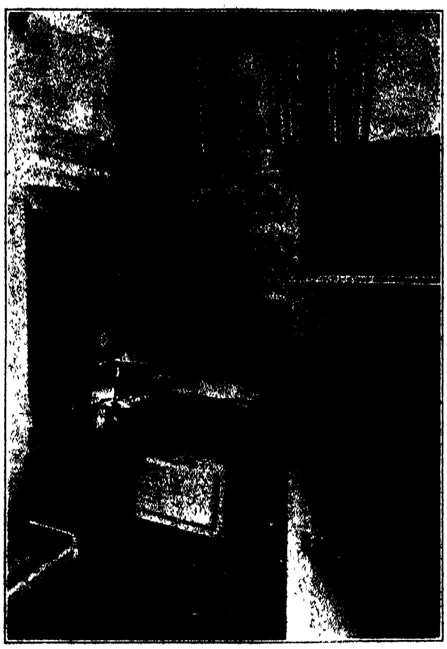
ALL the cement required for the recent construction of a 16-mile concrete highway along the Allegheny River in mountainous Warren County, Pennsylvania, was pumped across the river in dry bulk through a three-inch pipe.

Compressed air at 100 pounds pressure carried the cement in powdered form from freight cars a distance of 768 feet, the length of the pipe, to the batching plant. This unusual method of handling cement proved thoroughly practical and economical. The pipe was suspended across the river from a cable.—*Science Service.*

Ford Profits—81,797,861 Dollars

AFTER showing a deficit for 1927 in excess of 42,000,000 dollars due to the shut-down the latter half of the year for re-tooling incident to the production of the new model, and a deficit of over 72,000,000 dollars for 1928 due to large expenditures to bring up production, the Ford Motor Company showed a profit of 81,797,861 dollars for 1929, the second year of production of the Model A. These figures are given in the annual balance sheet filed recently with the State Commissioner of Corporations of Massachusetts.

Profits for last year were equal, according to *The New York Times*, to $473.79 a share on the 172,645 shares of stock, all of which are held by Henry Ford, Mrs. Henry Ford, and their son, Edsel Ford.



More evidence of the machine age in which we live. View of an electric range on one of the latest German motor buses. It was shown at a Berlin automobile show recently

Floodlight Units Help Prevent Liquor Smuggling

BY an odd twist of the illuminating engineer's mind, the Aqualux underwater floodlight, usually operated under water for the illumination of swimming pools and fountains, is now used to help keep the United States dry.

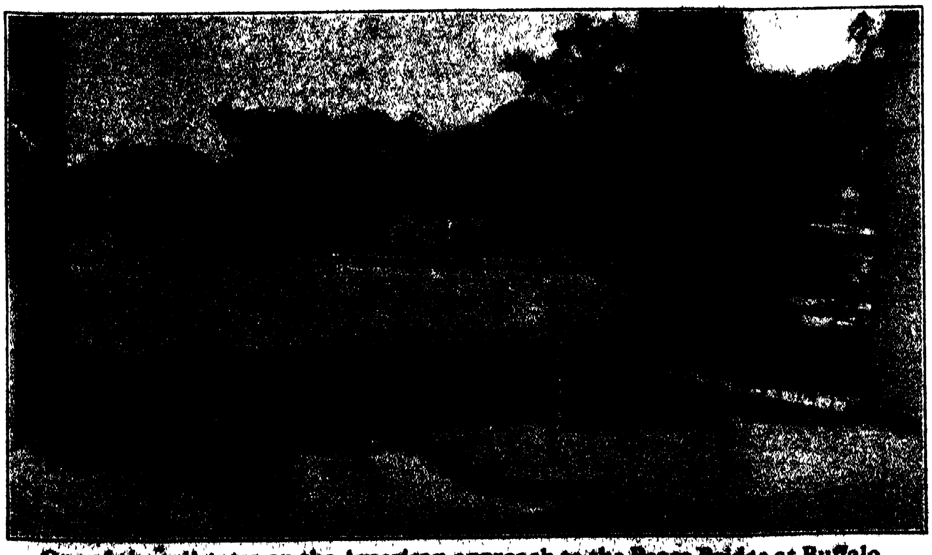
A unique method for enforcing the Volstead Act has been worked out with the United States customs and immigration officials. One of the installations has been made on four of the traffic lanes on the Buffalo end of the new 4,000,000-dollar Peace Bridge linking the United States with Canada.

It was found that a few of the cars returning to the United States over this bridge had hiding places constructed on the underside designed to contain quantities of contraband. Such hiding places, it was thought, could not be detected. It was a different story, however, after the floodlights were installed.

Three Westinghouse floodlights are buried in the concrete in the center of each traffic lane, and are equipped with 100-watt Mazda lamps which are completely enclosed by the waterproof housings. The spread lenses are protected by a heavy iron reinforcing rod embedded in the concrete over each light. The Aqualux floodlight is a cubical cast-aluminum box 8⅞ inches on a side with a gasketed cover containing an 8⅜-inch spread roundel. A chromium plated metal reflector is supplied in order to withstand the severe operating conditions.

With the car well illuminated on the underside, a view is obtained by merely looking downward into mirrors which are located for a distance of 10 feet along the curb, and set at an angle of about 45 degrees. These are five and one half inches high and are also protected by iron rods set in the concrete.

When a car stops in the lane for the usual inspection, the customs officer can see at a glance the details of the underside of all cars. If he sees the usual machinery and open spaces, there can be but little concealed. But, if the mirrors reflect large areas of sheet iron, or suspicious boxes or tanks, the car is ordered out of line for closer inspection of under-body parts.



One of the toll gates on the American approach to the Peace Bridge at Buffalo, showing the under-car lights and mirrors for detecting contraband in cars

Learning to Use Our Wings

Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

Experiments in Fog Flying

EXPERIMENTS in blind flying, under the auspices of the Daniel Guggenheim Fund for the Promotion of Aeronautics, were recently related by Lieutenant James H. Doolittle before the Society of Automotive Engineers.

A number of flights including 180-degree turns were made with remarkable accuracy, with the pilot seated in an entirely covered cockpit, and an assistant in the rear cockpit to take charge in case of emergency.

Success was due as much to the remarkable instruments employed as to the skill and pluck of the pilot. The instrument board of the *N Y 2*, Consolidated training plane employed in these tests, is shown in one of our photographs. The instruments included standard tachometer; oil pressure gage; oil-temperature gage; airmeter; voltmeter; compass; bank-and-turn indicator; air-speed indicator; altimeter; and rate-of-climb indicator. In addition, a very sensitive Kollsman altimeter, graduated in 10-foot intervals, a Sperry artificial horizon, and a Sperry directional gyroscope are shown in the photograph.

The directional gyroscope is not truly a gyroscope compass because it does not seek the north, but once set in a given direction, it will maintain that direction without serious error for a two-hour period.

Another very useful instrument employed was the Sperry artificial horizon. Here again a gyroscope is employed (driven by a small air turbine which is connected to a Venturi placed in the airstream) in this case with its axis placed in a vertical position. The instrument is so constructed that a tiny airplane is seen by the pilot to be in normal attitude, climb, dive, left wing low, or right wing low, according to the position of the plane on which the instrument is mounted.

An airplane cockpit equipped for experimental flights under conditions simulating flying in fog

The ground radio equipment consisted of (a) an audible-type radio-beacon, the purpose of which was to direct the incoming airplane to the vicinity of the field or to keep the outgoing airplane on its course, (b) a visual type localizer-beacon, the function of which was to lead the pilot to the exact point where he should touch his wheels in landing; and (c) a ground receiving and transmitting set.

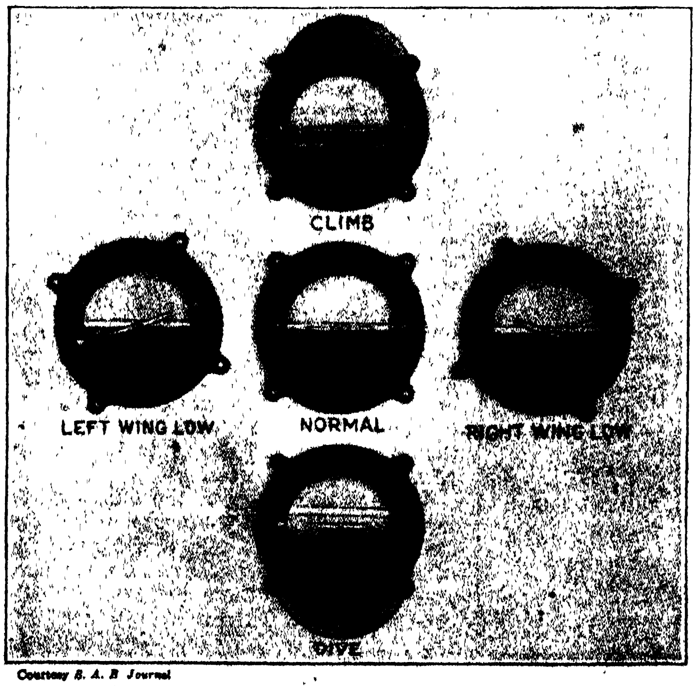
The visual-type indicator consisted of two vibrating reeds, indicating to the pilot his position with respect to the beam center. When to the right of the beam, the right reed vibrated through a greater amplitude. When to the left of the beam, the white streak caused by the vibration of the left reed became longer. When exactly over the center of the beam path, the reeds vibrated with equal amplitude. Upon approaching the beacon house, the intensity of the signal increased rapidly. At the exact moment of passing over the beacon house, the reeds stopped momentarily, and then started to vibrate again in the opposite direction.

The beacon employed was of the loop type entirely enclosed in a small building, with no wires on the outside. In the center was the goniometer which tunes the loop aerial, so that the correct guiding beam was transmitted to the pilot.

The airplane was taxied out onto the field in position for the take-off, and directly on the radio beam. The altimeter was set at zero, and the gyros speeded up. At take-off the pilot was able to hold the airplane straight by the gyro and the tail in the proper attitude by the artificial horizon.

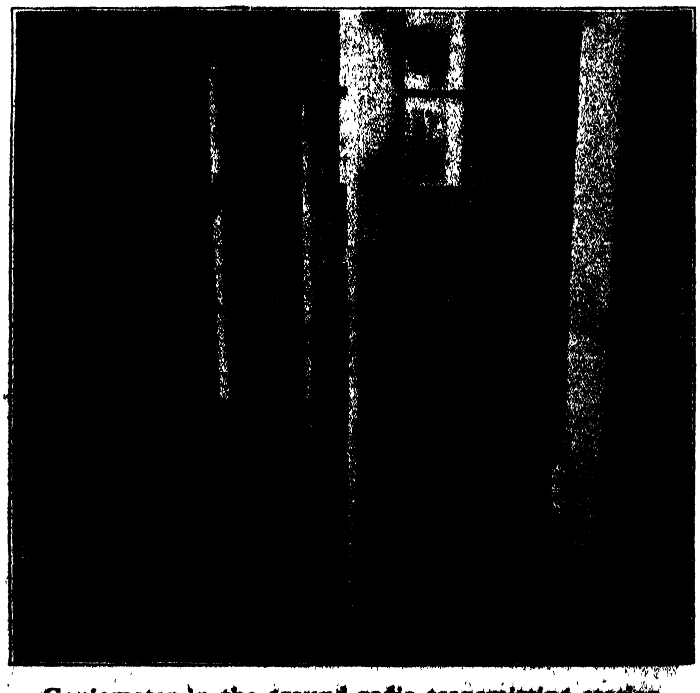
The localizer beam was followed for about four miles and the plane climbed to about 1000 feet. A 180-degree turn was made at this point and the beam followed to the beacon. As the beacon was approached the beam became narrower, and the course more exact.

Upon passing over the beacon house again, the reed stopped vibrating, the engine was throttled so that the plane came down to a speed of 60 miles per hour, the plane was kept absolutely level by the artificial horizon, and then flown directly to the ground without leveling off. The



Courtesy S. A. E. Journal

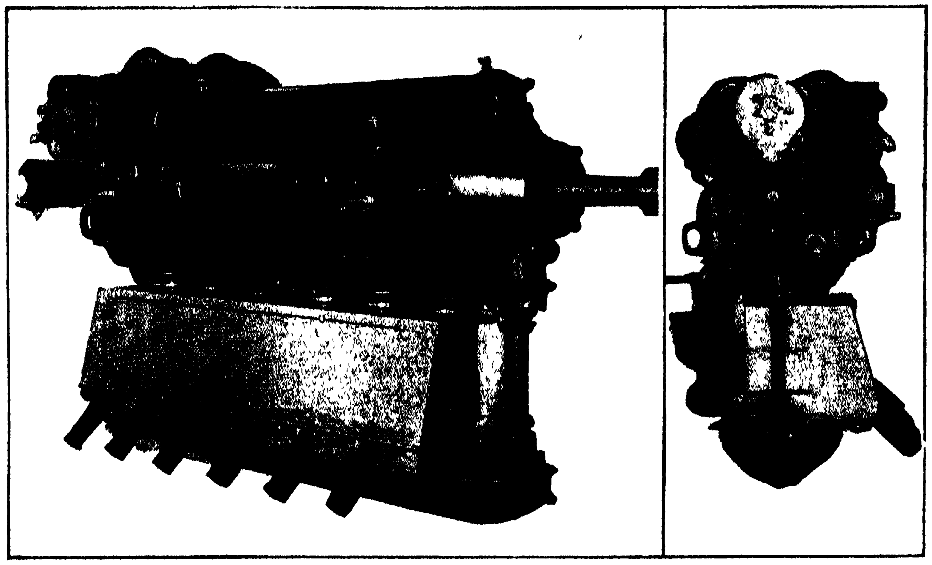
The Sperry artificial horizon. See text above



Goniometer in the ground radio transmitting station shock of landing was uncomfortable but could probably be eliminated by correctly designed landing gear.

"Had the airplane actually been coming into a fog-bound airport from a distant point," said Lieutenant Doolittle, "it would have come in along the audible-type beacon until it arrived at a point which indicated the intersection of the audible and visual-type beacon beams. At this point the pilot would radio in and request that the more powerful beacon be shut down to avoid interference. He would then follow on along the localizer-beacon beam, and at the same time request the ground barometric pressure, wind direction, ceiling, and visibility under the fog. Next the pilot would set off the correct ground pressure on his altimeter and put himself in the proper position to land into the wind."

These tests covered several months, and hundreds of landings were made without breakage. They are extremely encouraging, even if they cannot yet be considered commercially applicable.



Side and end views of the Fairchild 6-390 engine described below

Plumbing and Heating in the Air

IT is extraordinary how the airplane constructor has to reach out into every industry and trade to make his craft really comfortable for the passenger. In the matter of plumbing and heating, the aircraft designer has had to become his own plumber because the trade could not supply him with sufficiently light and compact equipment. John F. Hardecker, writing in *Domestic Engineering*, describes some of these very interesting developments.

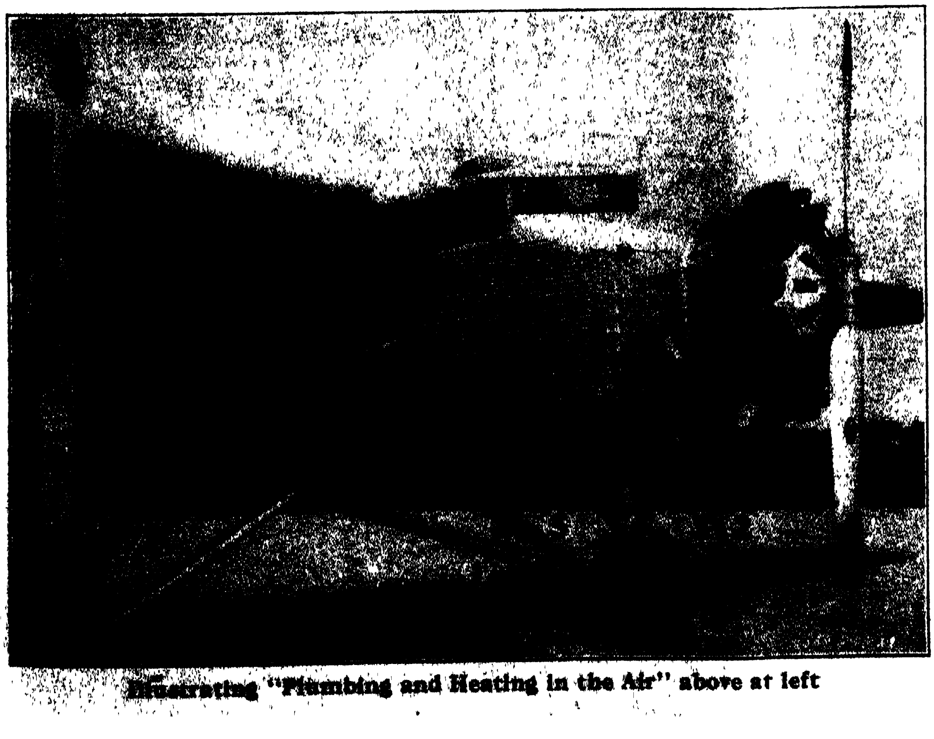
In the matter of plumbing, the limitations in the airplane are very severe. The fixtures must be light and small, because space is very valuable. Governmental regulations rigidly prohibit the discharge of any waste while in flight.

Designers have met these limitations by providing light combination water tanks and washstands of polished metal, weighing less than five pounds. Water tanks have been made of triangular and quarter-cylinder shapes so as to fit in corners and against cabin walls. A folding washstand has been developed which weighs only three pounds and fits snugly against the wall when not is use. Chemical hoppers have been provided, with sloping bottoms so as to fit sloping floors. Lavatory compartments on large passenger planes are fully equipped with washstands, closets, towel racks, small cupboards, and so on.

In the matter of heating, similar ingenuity has been displayed. Thanks to the courtesy of *Domestic Engineering*, we are able to show a special photograph indicating the heating arrangements on the Ford tri-motors now in use on the T. A. T. lines. The center motor exhaust pipe is installed along the under side of the plane. Over the exhaust pipe a large housing is placed with a clearance of approximately one inch on all sides. The bottom of the plane is protected by a heavy sheet of asbestos.

Fresh air is taken into the housing at the point 1 on the photograph. As the air passes through this housing it is warmed by contact with the hot exhaust pipe. The warm air is directed into the cabin by pipes of sufficient size, located in the floor at the center of the cabin. Registers may be opened or closed at the will of the passengers. The valve located at the end of the exhaust housing, at point 4, is operated by the last register in the cabin. When this register is closed, the valve is opened and allows the hot air to pass out to prevent overheating of the cabin. The funnel shaped opening, at point 2, and the register, at point 5, lead heated air into the cockpit. The opening at point 3 is for heating the air for the carbureter and operates in the same fashion as the cabin heater.

This simple and inexpensive method of heating has proved entirely satisfactory in practice, although temperatures under operating conditions vary from 35 degrees below zero, Fahrenheit, to 135 degrees above, and the flying ranges to 12,000 feet altitude.



Illustrating "Plumbing and Heating in the Air" above at left

A New Inverted Engine

THE in-line air-cooled inverted engine for small planes is still growing in popularity. This type offers somewhat less head resistance than the star or radial air-cooled engine and also less hindrance to the vision of the pilot. The pilot's vision is particularly satisfactory when the in-line air-cooled motor is inverted. The development of a six-cylinder in-line air-cooled engine by the Fairchild Engine Corporation is therefore of considerable interest to the aviation industry as a whole. The Model 6-390, as this new engine is called, has the following specifications:

Bore	4"
Stroke	5⅛"
Total displacement	386 cu. in.
Compression ratio	5.2 to 1
Weight dry	335 lbs.
115 h.p. at 2000 r.p.m.	
Fuel consumption—.55 lbs. per BHP/hr at rated power and speed.	

The engine has undergone a satisfactory 50-hour non-stop run at approximately full power.

The crankcase of the 6-390 is in two parts, and designed with special reference to ease of maintenance. A novel feature in the design is the use of four finished pads, two on each side, for mounting the engine. This makes for ready installation and removal of the engine from a plane.

The camshaft and rockers at the bottom of the engine are supported and enclosed by a housing, the cover of which serves as the engine oil sump. This makes for less noise and greater cleanliness.

The airplane pilot and mechanic should be particularly pleased with the grouping and location of the accessories on this engine, which are all placed towards the rear. Through a single opening about 12 inches by 16 inches in the cowl over the engine, it is possible to get at all the accessories as well as the starter and generator, oil pressure relief valve, and tachometer drive connections.

Glider Carnival Postponement

POSTPONEMENT of the New York Glider Carnival till late in June was announced by Edward P. Warner, chairman of the Carnival Committee. The event was originally scheduled for April 25 and 26 at Queens Borough Golf and Country Club, Bayside, L. I., N. Y.

The Carnival was postponed in order to allow a number of organizations which had entered, sufficient time to complete the construction of gliders which they will fly. This action was taken following a meeting of the executive committee, which consists of Miss Amelia Earhart, Norman Siegel, C. T. Stork, and E. P. Warner.

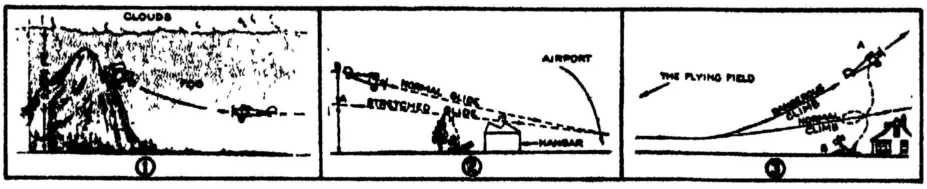
Postponement to a date late in June also will enable a number of the collegiate glider organizations to take part in the event, Mr. Warner pointed out. The program of 14 events for novice, second, and first class glider pilots will remain the same as scheduled for the earlier date.

Avoidable Causes of Accident

A FORMER Bulgarian army pilot, A. Jordanoff, has graphically depicted some avoidable causes of airplane accidents in the *New York Times*. These sketches are reproduced below.

1, indicates a plane striking the side of a mountain in a fog. Some sensitive warning of the presence of the mountain is an invention still to be made. The present remedy is to land rather than to attempt to fly through fog at low altitude.

A misguided effort to stretch a glide by putting the plane at a large angle of incidence and so getting it out of control is illustrated in 2. The longest glide from a given altitude occurs at an angle of attack of about four degrees for the wings. Raising the nose slows down the speed of the glide, but actually diminishes the gliding radius.



Above and below: Illustrations of six avoidable types of accidents

The dangers of too steep a climb are shown in 3. If the climb is too steep, the engine may not provide enough power to maintain the climb, the wings may stall, and loss of lift and control lead to trouble.

Turning in a sharp climb may be dangerous, as shown in 4. We beg to differ with the author-artist here. Once the airplane is up aloft in a steady wind, the wind has no effect on its maneuver relative to the air—whatever may be its effects from the point of view of ground speed.

The golden rule is illustrated in 5. Never attempt to turn back when the engine quits. Turning without power may result in a stall, with consequent disaster.

Illustration 6 speaks for itself. Stunting at low altitudes is always dangerous.

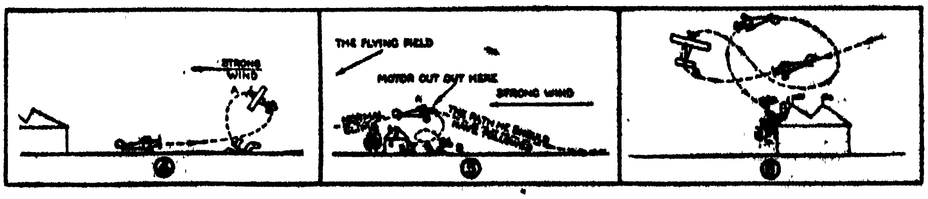
Such diagrams published in the daily press may give the public an erroneous idea of the hazards of flying, but, on the other hand, if every pilot took such rules to heart the number of accidents would be greatly diminished.

Testing Gasoline in the Air

THE importance of using the best gasoline for aircraft is of course obvious and a great many of the large oil companies now have special aircraft gasoline departments with experienced aviation men at their heads, ready to supply pertinent information to aircraft engine builders and operators.

Equipment in cockpit for use in testing gasoline during flight

The Natural Gasoline Association of America, in collaboration with the Phillips Petroleum Company, has gone a step further by equipping a Wasp engined Travelair monoplane with a complete set of instruments for testing gasoline under conditions of actual flight.



The accompanying photograph shows the installation of the switch panel and recording instruments in the cabin of the plane, using delicate thermocouple and resistance thermometers. A most comprehensive survey of temperatures may be made at any one time; namely, temperature of the right wing, temperature of vapor space and gasoline in the tanks, temperature in the gasoline feed line, temperatures in the carbureter bowl, fuel pump, strainer, air intake, cylinder heads, and temperature in cylinder-head flanges.

If these temperature measurements are accompanied by the usual determination of altitude, air speed, and climbing and gliding angles, it is clear that a very thorough study of the motor's operation will be available. The temperature of the engine parts has an obvious bearing on the reliability of the motor.

Model Meet

A NEW YORK State model airplane meet will be held at Binghamton, New York, on May 30 and 31. Junior events will be for boys under 15 years of age, and senior events for young men from 16 to 21 years of age.

Outdoor models are to be twin pushers or tractors with 40-inch fuselages and a minimum wing surface of 125 square inches. Indoor models are to be somewhat smaller, with single tractor or pusher, propellers and with 15-inch fuselages and 24-inch wing spreads.

Nothing spreads interest in actual flying as much as the education of our youngsters in model work.

Radio "Flag Stops" in Air Transport

A MOST interesting development is the introduction of flag stops by the Transcontinental Air Transport. In order to serve more cities along its route, the T.A.T. has created three flag stops along its transcontinental line; one at Vandalia, Ohio, about nine miles north of Dayton; one at St. Elmo, Indiana; and one at Terre Haute, Indiana. Passengers will be able to board the planes at these points by simply notifying the company's representatives in time to have the pilot instructed. This will be done by radio while the plane is in the air.

Progress on the Lindbergh Line

WORKING in active co-operation with the Pennsylvania and Atchison Railroads, Transcontinental Air Transport Lines have issued interesting figures regarding the first six months' operations of their transcontinental air lines called the Lindbergh Line, in recognition of Colonel Lindbergh's service as Chairman of the T.A.T. Technical Committee.

Since its inauguration last July, T. A. T. has carried 4846 passengers for a total of slightly more than 2,000,000 passenger miles.

Its operating ratio, obtained by balancing the number of miles scheduled against the miles flown, has been 90.5 percent. There were 603,700 miles scheduled and 545,854 miles flown. Out of the 669 trips scheduled, 578, or 86.5 percent, were completed, and 70.6 percent of the plane arrivals were on time. These figures are quite encouraging and it is to be expected that, as confidence increases, a great many more passengers will be carried during 1930.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Dead Sea Becomes Center of Live Industry

THE Dead Sea, in Palestine, long known to contain potash and other valuable salts, is now being exploited by a chemical company which will recover potash from its historic waters. Palestine Potash, Ltd., has been formed in London with 2,000,000 dollars in capital to exploit the chemical resources of this body of water. Actual work will be begun immediately at the confluence of the River Jordan and the Dead Sea, where elaborate drying plants have been erected and 400 workers engaged.

The Earl of Lytton, former Viceroy of India, is chairman of the new company, which intends to increase its capitalization as business warrants. Shares already have been subscribed by the British and American directors, but additional shares will be offered to the public in accordance with the terms of the concession. Among the American directors are Felix Warburg and Bernard Flexner of New York.

Although the start necessarily will be slow, the company is bound by its concession to produce at least 50,000 tons of potassium chloride annually after the tenth year. The work will be carried out by means of huge drying tanks built on the hills on each side of the mouth of the Jordan.

The water of the Dead Sea, which is 300 feet below sea level, is said to be among the world's richest repositories of valuable salts, and potash is expected to become one of Palestine's most important products. The potash will be taken by motor truck to Jerusalem and thence to Haifa by rail for export.

Automatic Control of Gasoline Plant

THE chemical engineer is not slow to adapt the ingenious devices of the electrical and mechanical engineer to his own problems, thus providing automatic control for the operations with which he is concerned. Often, a few degrees variation in temperature will make the difference between success and failure in a chemical reaction, so the automatic thermostat is called into use to keep its tireless vigil over many a vat, still, or digester. An equal degree of mechanization is now being realized in the control of pressure. Thus, for example, in the recovery of gasoline from natural gas, a very careful control of pressures in pipe lines and towers is essential. J. V. Thomas, in a recent issue of *Chemical and Metallurgical Engineering*, describes the almost human devices which take the place of manual control in plants of this kind.

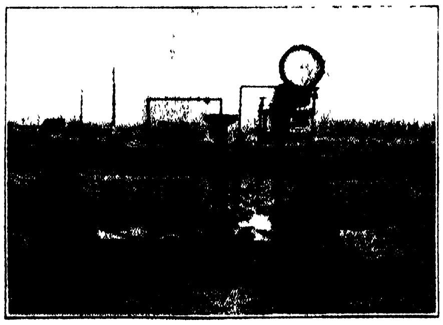
Not only are pressures and temperatures controlled automatically, but liquid-level controllers maintain constant levels in tanks and absorption towers.

Mystery of Poison Island Solved

WHEN a large number of workmen, engaged in building a new power plant for the Duquesne Light Company, on Brunot Island in the Ohio River near Pittsburgh, were mysteriously overcome on the job, the engineers decided it was time to call in the chemists. A hurry call to the United States Bureau of Mines, Pittsburgh Experiment Station, brought a corps of specialists equipped with breathing apparatus, gas masks, and gas detecting devices. On arriving at the construction project, it was found that the employees affected by gas had been overcome or partially overcome while changing clothes in a change-house before going to work. Tests made by the Bureau of Mines safety engineers with a carbon monoxide detector showed that there was approximately 1 to 2 percent of carbon monoxide in the atmosphere of the building.

Investigation as to the source of carbon monoxide disclosed one of the most novel occurrences of the gas that has ever come to the attention of the Bureau of Mines specialists. The entire upper end of the island has been formed by the dumping of cinders from a boiler plant operated for a period of at least 20 years. This bed of cinders and ashes is at least 40 feet in depth in various places. Various sections of this cinder-ash field had been on fire as recently as two or three months previous. Thus a great area was giving off carbon monoxide, the formation of the deadly gas from the cinders being similar to the formation of water gas.

An intake tunnel was being constructed under the cinder-ash field, and the compressed air from the tunnel, under about 7½ pounds pressure, was being forced up through the cracks and the interstices similarly to the passage of air through a blacksmith's blower. This air movement increased the production of carbon monoxide, the formation of which was also considerably aided by the melting of a fairly heavy snow followed by rain, resulting in little or no air movement on the surface. The change-house in which the employees were overcome was located several feet from the site of the tunnel, illustrating the widespread distribution of the carbon monoxide.



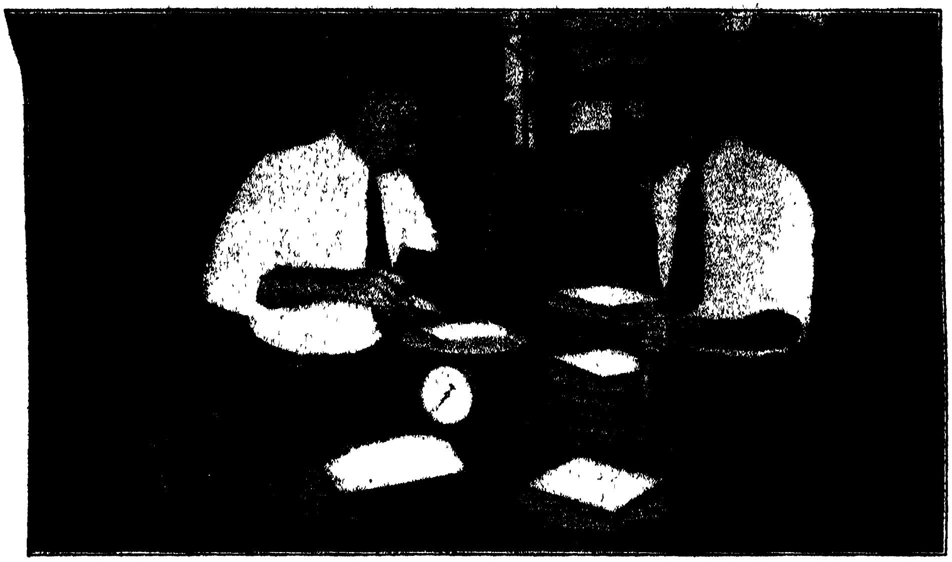
Automatic regulator used in gas line to reduce the pressure from 250 to 5 pounds, and maintain it

These pressure regulators, liquid level controllers, and temperature controllers are used in automatically maintaining a stabilizing column in a gas plant

Electrocute Methane to Form Acetylene

AT the Kaiser-Wilhelm Institute für Kohlenforschung, Germany, chemists have developed an "electrocuting" apparatus through which they pass a gas such as methane, whereupon it emerges as acetylene. Almost any of the hydrocarbons, when subjected as gases to the "shocking" effect of this electrical device are converted to something else, indicating that the effect of the discharge is to blow the molecules of gas into atoms which then rearrange themselves into new combinations, something like a game of electrochemical puss-in-the-corner.

Of the several kinds of electrical discharges which have been applied to chemical reactions, the most important from the practical standpoint are the arc, the silent discharge, and the low-pressure discharge. The arc process has been used, notably in Norway, for the conversion of the nitrogen in air into nitric acid. Another use of the arc discharge in chemistry is the production of carbon black and acetylene from



Weighing quartz crystals in the trays in which they will be melted to form window panes, and loading the trays on the holder for the electric furnace

hydrocarbon gases. The silent electric discharge is useful for its polymerizing effect and for activating gases. Its industrial use is limited by low yield and low current density. Low-pressure discharge gives a useful means of effecting endothermic and ionic reactions at relatively low temperatures.

The Germans have now found that not only methane but the higher hydro-carbons (naphthalene, anthracene, petroleum oils, and even pitch) can be converted into acetylene by a low-pressure discharge. In the presence of nitrogen, prussic acid can be obtained. Removal of products as formed makes possible excellent yields in the laboratory trials. Production on a commercial scale has not yet been accomplished, but energy relations and other considerations which affect costs do not indicate any fundamental obstacles.

Making Glass Which Passes Health-giving Rays

WHILE it is only recently that electrical manufacturers have developed lights which artificially produce the health-giving rays formerly available only in natural sunlight, nevertheless, the beneficial effects of these rays has been known for centuries. The ancient Egyptians were familiar with the benefits of sunlight.

The importance of ultra-violet rays of the sunlight to health and the fact that ordinary window glass cuts out nearly all of these beneficial rays has long been recognized. Several years ago Professor Elihu Thomson, director of the General Electric's great research laboratory at Lynn, Massachusetts, took up the work of developing a material which would transmit the health rays, to replace window glass. Fused quartz was known as the best medium for the purpose but to make window panes of it was a problem that required years to solve. The difficulties of making quartz windows can be appreciated when it is realized that the melting point of quartz approaches a temperature of 3200 degrees Fahrenheit, about three times that of glass. Moreover, it is extremely viscous, or thick. Many methods were investigated and special furnaces were developed before the engineers finally succeeded in making quartz in sheet form, and at a reasonable cost.

One of the first methods developed to produce a high quality quartz glass consisted in fusing, in a vacuum, specially selected and treated quartz crystals in a square fabricated graphite box, and pressing the fused mass of quartz at 1000 pounds per square inch while in the molten state. A block of quartz 8 by 5 by 5 inches was thus obtained. This block when cooled was sliced into sections one eighth inch thick and each pane was ground and polished by hand.

This method of manufacture was considered too expensive for common use, and further research was carried on to get a satisfactory quartz window that would be sufficiently reasonable in cost that the benefits of fused quartz could be available for more general use. This additional development work resulted in an entirely new process which cut the cost of manufacture to about one fifth of previous costs and made it feasible to use quartz in large solariums.

In the present process, quartz crystal, crushed to one quarter inch mesh, is fused in a vacuum on flat graphite disks between thin graphite slabs in the form of a 7¼ inch square. A number of these trays are stacked in a form and placed in a high-temperature furnace. When the quartz is fused, nitrogen gas is admitted to the furnace at a pressure of 150 pounds per square inch to compress the bubbles. The resulting quartz plates, upon cooling, require only squaring of the edges by grinding. The plates themselves are 7¼ inches square by one quarter inch thick. This new method does away with cutting, grinding, and polishing each pane, and the trays can be used a number of times.

United States Alcohol Consumption only Half Capacity

ETHYL alcohol ranks first in quantity and value of production of all organic chemicals. It is a basic raw material in the chemical and process industries and finds application in a multitude of products. An approximate distribution of denatured alcohol by uses is as follows:

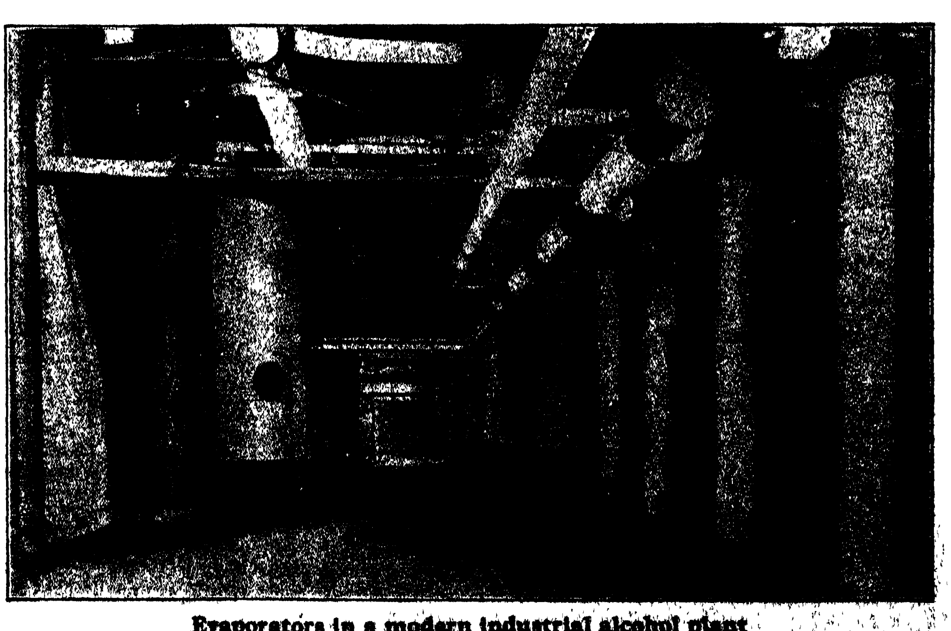
	Wine Gallons
Anti-freeze	40,000,000
Cellulose industries	25,000,000
Shellac and varnish	8,000,000
Toilet and perfume preparations	5,000,000
Miscellaneous	15,000,000

The total available capacity in the United States for producing alcohol, says W. N. Watson, of the United States Tariff Commission, writing in a recent issue of *Chemical and Metallurgical Engineering*, is about 220,000,000 wine gallons, of which about 15,000,000 wine gallons is for production from grain, and the balance, 205,000,000 wine gallons, from molasses. The annual consumption is about 100,000,000 wine gallons, or somewhat less than one half the present capacity. The capital invested in molasses alcohol plants is about 55,000,000 dollars and in grain alcohol plants about 5,000,000 dollars.

In the manufacture of alcohol from corn, the by-products consist of distillers' grains, a valuable cattle feed, which has sold in recent years for from 35 to 45 dollars per ton, or on an average of about 2 cents per pound. Each bushel of corn gives about 12¼ pounds of distillers' grains. In addition, fusel oil is another by-product of small importance, and in certain cases, corn oil and corn-oil meal are obtained.

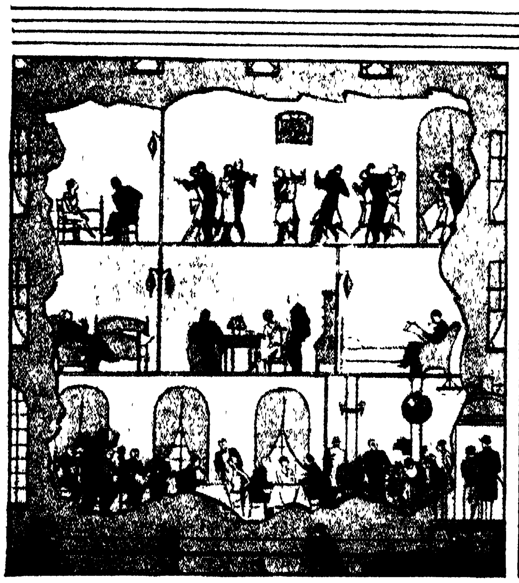
It is estimated that if all the alcohol produced in America were made from corn,

(*Please turn to page* 483)



Evaporators in a modern industrial alcohol plant

BUILT-IN-MUSIC



A MODERN IDEA MADE POSSIBLE BY WESTERN ELECTRIC

Many progressive hotels now fill their walls with music—yours to enjoy by simply switching on the loud speaker in your room.

Western Electric Public Address System enables a single orchestra to be heard in every room desired. And the same system—hooked up with a radio receiver or with the Western Electric Music Reproducer — distributes through the building broadcast programs or music from phonograph records.

In large meeting rooms this Public Address equipment makes all seats good. Even though you sit in the last row you hear every word as clearly as though up front. Schools, hospitals, public buildings, amusement parks and airports are using this system to widen the range of hearing.

This equipment, in refinement of workmanship, tonal quality and reliability, reflects the experience gained by Western Electric in 50 years of telephone making.

Western Electric

PUBLIC ADDRESS AND MUSIC REPRODUCTION SYSTEMS

Distributed by GRAYBAR ELECTRIC *Company*

MADE
BY THE MAKERS
OF YOUR
TELEPHONE

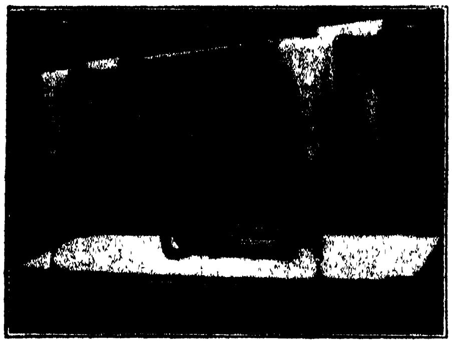
The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Care of the Crippled

WITHIN the last few years special attention has been paid throughout the world to the use of the swimming pool method for developing and educating tissue that has lost its function through infantile paralysis. Among the leaders has been the Orthopedic Hospital of Los Angeles. There a special pool was built in which all forms of paralysis are treated. The chief values of the pool treatment seem to be the greater ease and freedom of movement in painful conditions, the easier handling of painful joints and easier development of weakened muscles, the fact that the water bears the weight, the enjoyment and interest, and the special value of the baths on the general morale of the patient.



Traveling hoist with hand control. New apparatus for carrying patients will be electrically controlled

In developing a pool particularly for this purpose, arrangements have been made for carriers which deliver the patient at the pool and for special sprays to clean the patient before entering the pool and on leaving. Foot baths are provided and cleanliness is carefully controlled by chlorination, and by the use of copper salt for algae. Metal equipment is made of bronze, chrome nickel or enamel so that it will not be corroded by the chlorine in the water.

Special tables have been arranged which allow the head and shoulders of the patients to be supported out of the water, and permit the attendants to manipulate the tissues while the patient is in the water.

As may well be imagined, such special equipment is exceedingly costly, but it is of value in the relief of pain and the cure of defects, which makes cost a secondary consideration.

First-Aid for Motorists

APPARENTLY European countries are far beyond our country in anticipation of the difficulties associated with modern tourists and their safety. France has had established for some time a series of first-aid stations along many of the highways. The Red Cross Society of Belgium established its first-aid stations three years ago and now has a complete series of them in working order along the roads from Brussels to Ostend, Antwerp, Liege, and Namur.

Because of the tremendous number of roadside accidents in this country, the American Red Cross might give serious consideration to this work. Persons who are injured are usually carried by the first passerby to some hospital. Hospitals are dubious about taking care of such patients, particularly when they come from outside the state, and the whole problem of responsibility for the care of the patient is in doubt.

Operations on the Heart

IT is not so long ago that any operation on the human heart was considered invariably fatal. With gradual improvement in methods of operation and in the use of anesthetics attempts were made to do various surgical operations involving the vital organ. In this country men have had wounds of the heart sewed up, a bullet has been removed from the heart, and in one instance the heart was opened, a constricted valve cut, and the patient recovered.

In a recent meeting of the Vienna Medical Society several interesting cases were presented in which operations had been performed on the heart. In one case a man was stabbed and when the patient was opened the wound was found to have penetrated the outer covering of the heart and the heart itself. The heart had apparently stopped beating. The space between the outer covering of the heart and the heart itself was filled with blood clots. The sac was opened and the blood clots were removed, whereupon the heart began to beat. The heart was sewed, the outer covering was sewed, and the wound in the chest closed.

Another instance was reported in which a bullet had penetrated the heart. When the body was opened and the heart examined, an opening was found into the heart, but no exit opening was found. The opening was closed and during the operation the heart stopped. After massage it began beating again. The use of the X-ray some three months later showed the projectile buried in the tissue of the heart, but the patient up to that time had not suffered any unusual symptoms.

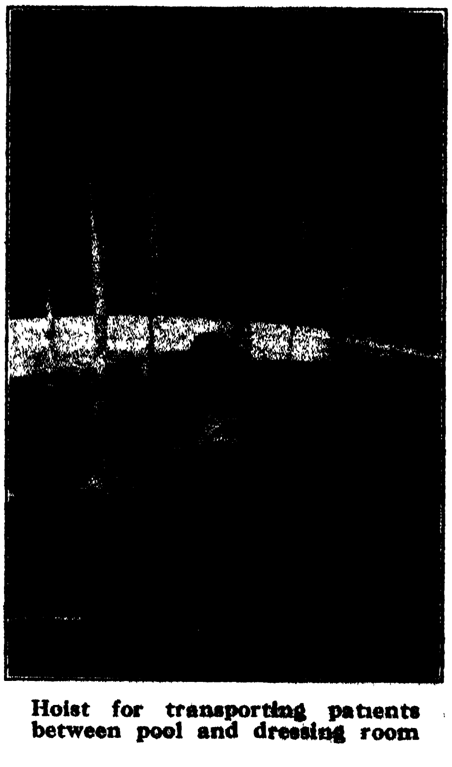
Hospitals of the United States

ONE of the most interesting phenomena of the last quarter century has been the rise of hospital care in this country. There are today 6665 reputable hospitals providing 907,138 beds and 47,939 bassinets. This is an increase of 486,068 beds or 115.4 percent since 1909. The average number of people constantly in hospitals in 1929 was 726,766. There are approximately 150,000 physicians in this country, of whom about 125,000 are in practice. It is almost impossible to realize that 98,491 doctors have connections with hospitals and indeed 84,579 are actually attending in such institutions.

Sinus Infection and Vitamins

IT has long been known that vitamin A deficiency produces an inflammation of the eyes. More recently it has been quite definitely shown that vitamin A is related to the resistance of the human body against infection. Following a deficiency of vitamin A in the diet, rats develop inflammations of the eyes, infections of the nasal passages and sinuses, of the ears, the tongue, and even of the lungs. Most investigators are now convinced that the value of cod-liver oil in preventing colds, if it has any such value, is due to the vitamin A in the cod-liver oil and not to the vitamin D.

In the research laboratories of the Detroit College of Medicine and Surgery, Drs. Burt R. Shurly and R. G. Turner made a special study of the relationship of vitamin A to infections of the breathing tract, and particularly of the sinuses. They made a special study of the bacterial organisms found in animals which had been on vitamin deficient diets. They found certain organisms in such cases which were especially virulent.

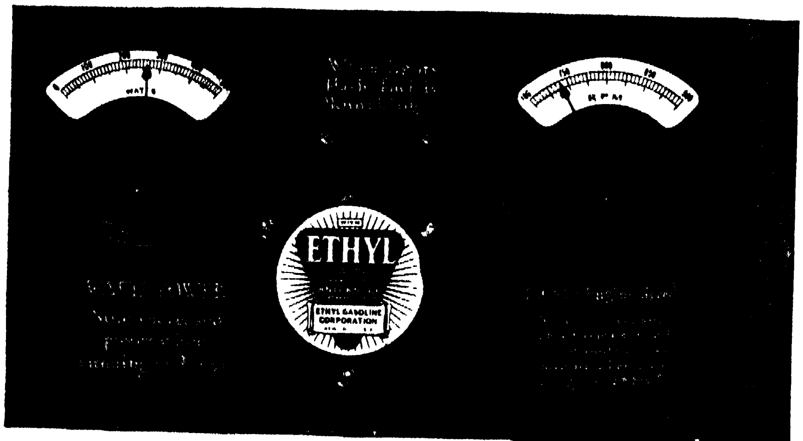


Hoist for transporting patients between pool and dressing room

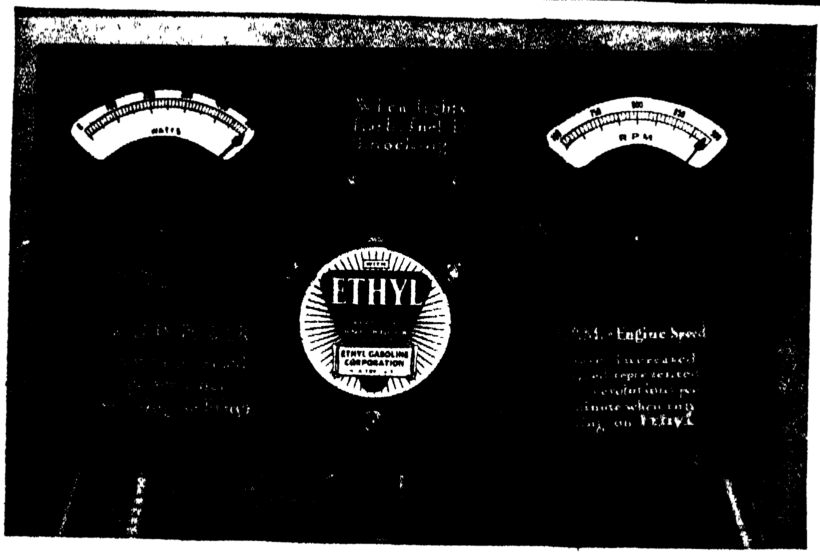
In the University of Iowa, in 1916, Doctors Daniels and Armstrong showed that deficiencies in diets encouraged infection of the sinuses as well as of the ear. There seems to be no doubt that deprivation of vitamin A permits germs to exercise extraordinarily virulent effects.

The *proof* that Ethyl develops more power

Right: This is the instrument board of a knock-demonstration machine. The wattmeter (at the left) registers power. The tachometer (at the right) records engine revolutions per minute. When this picture was made, the engine was running on ordinary fuel.



Below: When the lower picture was taken, Ethyl had been fed into the carbureter. The wattmeter shows that the power has risen to the maximum; the tachometer shows a corresponding increase in revolutions per minute.



"Knocks out that 'knock'"

ETHYL
GASOLINE

"SEEING is believing." These pictures of a knock-demonstration machine let you *see* how Ethyl Gasoline will increase the speed and power of your motor.

A simple valve switches the fuel from ordinary gasoline to Ethyl and back again. When Ethyl goes in, "knock" goes out, R. P. M.'s (engine revolutions per minute) increase, power goes up. That is how Ethyl improves motor car performance.

The Ethyl anti-knock compound in Ethyl Gasoline makes the difference. This remarkable fluid was developed by General Motors Research Laboratories after years of experiment to find an ingredient which would make gasoline a better fuel. Make this convincing experiment in your own car. Use up the ordinary gasoline in the tank; then fill up with Ethyl. You'll see and feel the difference.

* * * *

Wherever you drive—whatever the oil company's name or the brand associated with it—*any* pump bearing the Ethyl emblem represents quality gasoline of anti-knock rating sufficiently high to "knock out that 'knock'" in cars of average compression and bring out the additional power of the new high-compression cars. Ethyl Gasoline Corporation, Chrysler Building, New York City.

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The active ingredient used in Ethyl fluid is lead

Current Bulletin Briefs

Short Reviews of Bulletins and Papers on Scientific and Allied Subjects, and Where to Get Them

AXE MANUAL OF PETER MCLAREN (America's champion chopper). Axemanship as sport and as an art; how to handle an ax expertly and how not to; how to conduct a chopping contest, a new outdoor sport; how to put an edge on an ax scientifically. 84 pages illustrated. *Fayette R. Plumb, Inc., Philadelphia, Pa.—25 cents.*

TESTS OF LARGE TIMBER COLUMNS AND PRESENTATION OF THE FOREST PRODUCTS LABORATORY COLUMN FORMULA, by J. A. Newlin and J. M. Gahagan. (Technical Bulletin No. 167, Department of Agriculture). The authors have made a valuable contribution to timber mechanics. *Superintendent of Public Documents, Washington, D. C.—15 cents, coin.*

INDIAN CORN, by James B. McNair. A 33-page summary of information on our largest crop plant. Origin of corn; how Indians used it; modern industrial and experimental products such as starch; uses of corncobs (corncob flour, wood sugar) and of stalks (syrup, wall board, paper, artificial silk). *Field Museum of Natural History, Chicago.—Ten cents.*

PERMISSIBLE EXPLOSIVES — Information concerning their characteristics and their use in gassy and dusty coal mines. *E. I. du Pont de Nemours Co., Wilmington, Del.—Gratis.*

SAND AND GRAVEL IN 1928, by Estelle R. Phillips (Excerpt from Mineral Resources of the United States). Gives complete statistics of the industry. *Superintendent of Documents, Washington, D. C.—5 cents, coin.*

PULLMAN PROGRESS 1859–1929. A very attractive folder giving eight pictures in color of sleeping cars at various periods. Valuable for schools. *The Pullman Company, Chicago, Ill.—Free to teachers.*

ALLEGHANY PORTAGE RAILROAD. Interesting pamphlets on the forerunner of the Pennsylvania Railroad. *Publicity Bureau, Pennsylvania Railroad, Broad Street Station, Philadelphia, Pa.—Gratis.*

PORT OF HAMBURG (Foreign Port Series No. 1, Department of Commerce). Contains maps and 300 pages of information, bound in buckram. *Superintendentent of Documents, Washington, D. C. One dollar, money order.*

PORT OF LIVERPOOL. (Foreign Port Series No. 2, Department of Commerce). Contains 800 pages giving full information. There are maps, and it is bound in buckram. *Superintendent of Documents, Washington, D. C.—One dollar, money order.*

UPPER COLORADO RIVER AND ITS UTILIZATION. (Water Supply Paper No. 617 of the U. S. Geological Survey). It is of special interest to engineers and agriculturists concerned with projects in this district. *Superintendent of Documents, Washington, D. C.—65 cents, money order.*

TOBACCO AND ITS USE IN AFRICA by Berthold Laufer, Wilfrid D. Hambly, and Ralph Linton, is illustrated with drawings showing the many novel types of smoking equipment used by the natives in Africa. *Field Museum of Natural History, Chicago.—25 cents.*

YUKON: THE LAND OF THE KLONDIKE is a 46-page illustrated booklet showing the great changes that have taken place in the Yukon Territory since the storied days of '98. Both scenic attractions and industrial development are covered in the booklet. *Department of the Interior, Ottawa, Canada.*

FOR HOME LOVERS is the title of a new booklet illustrating houses of a wide variety of types, with floor plans and sketches showing construction details. *National Lumber Manufacturers Association, Transportation Building, Washington, D. C.—Gratis.*

ROMAN SURVEYING INSTRUMENTS, by Edward Noble Stone, is an illustrated short general description of the principal instruments used by Roman engineers in land-surveying and leveling, in laying out sites for camps and towns, and in the construction of roads and aqueducts. The descriptions and line drawings will prove interesting to present-day surveyors and engineers, as well as to students of Roman antiquities. *University of Washington Press, Seattle, Washington.—75 cents.*

THE NEW NEWS is a significant study of journalism and its place in the life of a great nation, particularly from the viewpoint of the advertiser. The publication is also interesting typographically, and presents some striking reproductions from line plates depicting modern America. *The United States Daily, Washington, D. C.—Gratis.*

YEAR BOOK FOR 1929. CARNEGIE INSTITUTION OF WASHINGTON. Summary of a single year's research in archeology, biology, chemistry, genetics, history of science, mathematics, meteorology, nutrition, paleontology, physics, physiology, seismology and others, conducted at the subordinate laboratories of this vast institution, each piece of research being described in a technical abstract. *Carnegie Institution of Washington.—One dollar.*

JOURNAL OF THE SOCIETY OF MOTION PICTURE ENGINEERS; published monthly, contains many important engineering papers on various topics pertaining to the technical improvement of motion pictures. *Secretary, Society of Motion Picture Engineers, 5th and Sussex Streets, Harrison, N. J.—$1.50 per copy to non-members.*

HOW THE 18-PERIOD CALENDAR WORKS IN BUSINESS, is a leaflet containing the views of executives of many prominent corporations which have adopted the use of the revised calendar. *National Committee on Calendar Simplification, 343 State Street, Rochester, New York.—Gratis.*

NATIONAL PHYSICAL LABORATORY REPORT FOR 1928. Detailed 270-page account of researches performed at Britain's institution corresponding to the United States Bureau of Standards. *His Majesty's Stationery Office, London, England.—9 shillings net.*

GREAT BRITAIN AND IRELAND, CALENDAR OF HISTORIC AND IMPORTANT EVENTS 1930 is a little booklet printed in black and red giving the principal events month by month together with information useful to travelers. *The Travel Association of Great Britain and Ireland, Kinnaird House, 1 Pall Mall East, London, S. W. 1, England.*

NICKEL-CHROMIUM STEELS FOR HIGH TEMPERATURE SERVICE VALVES AND BOLTS, by V. T. Malcolm. *The International Nickel Co., 67 Wall Street, New York City.—Gratis.*

SAFETY RULES, a pamphlet on safety in factories issued by the General Electric Co., Schenectady, New York. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.—Gratis.*

SAFETY PRECAUTIONS WHEN HANDLING ACIDS, ALKALIES AND POISONS. General Electric Company, Schenectady, N. Y. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.—Gratis.*

SAFETY RULES FOR MEN HANDLING ELECTRIC CIRCUITS OR APPARATUS. General Electric Company, Schenectady, N. Y. *Address G. E. Sanford, Chairman of the Safety Committee, 1 River Road, Schenectady, N. Y.*

RAYON AS A PAPER-MAKING MATERIAL, by Merle B. Shaw and George W. Becking, (Research Paper No. 143) is a reprint from Bureau of Standards Journal of Research. The test data indicates that rayon is valueless in the rag stock for high-grade papers and may actually be detrimental to their quality.—*Superintendent of Documents, Washington, D. C.—5 cents, coin.*

THE INCREASING USE OF THE TELEPHONE REQUIRES THE EXPENDITURE OF HUNDREDS OF MILLIONS ANNUALLY FOR EXTENSIONS AND IMPROVEMENTS

It keeps faith with your needs

An Advertisement of the American Telephone and Telegraph Company

You have found a constantly growing use for the telephone. You have learned its value in business. You have found it helpful in keeping contact with family and friends. Its increasing use has given the telephone its humanly important place in modern life and requires the expenditure of hundreds of millions annually for extensions and improvements.

In 1929 the Bell System's additions, betterments and replacements, with new manufacturing facilities, meant an expenditure of 633 million dollars. During 1930 this total will be more than 700 millions.

Definite improvements in your service result from a program of this size and kind. They start with the average time required to put in your telephone—which in five years has been cut nearly in half. They range through the other branches of your service, even to calls for distant points—so that all but a very few of them are now completed while you remain at the telephone.

In order to give the most effective, as well as the most economical service, the operation of the Bell System is carried on by 24 Associated Companies, each attuned to the part of the country it serves.

The Bell Laboratories are constantly engaged in telephone research. The Western Electric Company is manufacturing the precision equipment needed by the System. The staff of the American Telephone and Telegraph Company is developing better methods for the use of the operating companies. It is the aim of the Bell System continually to furnish a better telephone service for the nation.

The Amateur Astronomer

A Monthly Department

THE reader who decides to take up the home hobby of building and using an astronomical telescope—grinding and polishing his own glass optical parts and becoming one of a growing host of amateur astronomers—is urged to tackle nothing larger for his first effort than an instrument of six-inch diameter. Such a telescope will, however, magnify 50 to 200 diameters, depending on conditions. At a cost of about 25 dollars for materials (which can be obtained in a "set," that is, ready-to-use), if he possesses only average handiness he can make an instrument equaling in performance one he might purchase for 500 dollars. Hundreds of our readers scattered far and wide already have done this, using the practical working instructions in the SCIENTIFIC AMERICAN book "Amatuer Telescope Making," where numerous types are clearly described.

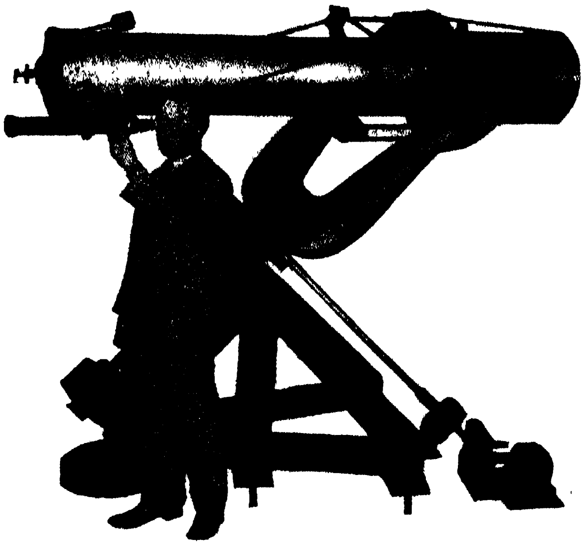
MR. W. L. Chamberlain, 519 Liberty Street, Meriden, Connecticut, sends in a photograph of his telescope and writes as follows:

"A talk on telescope making by one who had made a very successful telescope himself, inspired me to attempt the same thing. A friend loaned me a copy of 'Amateur Telescope Making,' and after securing glass disks and other materials, a start was made. The photograph submitted shows the finished instrument, a six-inch Newtonian reflector of 48-inch focal length.

"In grinding the mirror mistakes were made, as is usual with the novice, but the work proved to be so fascinating that the extra time required to make corrections was not regretted, for it was a good schooling in the art.

"Not wishing to be confined to a post and one location, it was decided to make the mounting of the alt-azimuth type, so that a tripod could be used as well. The sockets for the fork stem are identical on each. The fork, which has an offset angle, allows the tube to clear the post when directed at the zenith. The whole sky is seen.

"The post is an iron pipe 3½ inches in diameter, surmounted by a metal ball which just fits the inside diameter of the pipe. This ball is drilled and tapped for a short piece of steam pipe which makes the fork socket, and is held in place by three pointed set screws which are inserted through threaded holes near the top edge of the post into countersunk holes in the ball, one half of which protrudes out of the post. Two of these set screws are placed so that they form an axis on which the ball socket tube can be tilted over toward *Polaris*, thus forming a polar axis by which the telescope can be converted quickly into an English equatorial. The third set screw locks the ball in either position. The fork has two removable pins at the angle which, being reinserted in other properly located holes, straightens the fork as is usual in equatorial mounts.



Mr. Patton and his one-ton telescope

"When the telescope is used as an alt-azimuth, the eyepiece is inserted in the end of the declination axis. This gives the observer the great satisfaction of always having the eyepiece at the same height from the ground no matter where the telescope is pointed, and always directly above the post. This makes it possible to use a detachable bicycle seat on the post.

"The performance of the instrument exceeds my expectations. The definition is good. With my strongest eyepiece, estimated, with my focal length, to give 90 diameters magnification, the components of *Zeta* in Ursa Major are thrown wide apart, that is, *Sidus*, *Alcor*, and *Mizar;* and then the larger component *Mizar* is again split up into a close but clearly defined double. Star cluster M18 in Hercules gives momentary glimpses of individual components.

"I want to say a good word for honeycomb foundation strips in bringing up a low center when figuring a mirror. It is a most valuable addition to the possible methods of doing it."

Chamberlain's reflector

AN interesting, though brief, letter has been received from Mr. G. O. Neser, Senior Science Master at the Boys' High School at Paarl, South Africa. He writes:

"Sir:

"As I recollect seeing only one photo of a South African amateur's telescope published in your journal, I am sending you a snap of my reflector. It has a six-inch mirror, focal length fifty-two inches, and is mounted temporarily and rather precariously as shown.

"I am very much indebted to the SCIENTIFIC AMERICAN for initiating me into the mysteries of mirror making. I am starting on a 10-inch one shortly. Kindly have your book department forward me a copy of the latest edition of 'Amateur Telescope Making'."

MANY amateur telescope makers have jumped from six inch to eight or ten inch size on their second instrument, or even to larger sizes. Few have jumped quite so far, however, in refinement of mounting, as Mr. Ralph C. Patton of the Patton-Macguyer Co., Baker Street and Virginia Avenue, Providence, Rhode Island, makers of stampings and novelties. At our request Mr. Patton has prepared the following description of his instrument:

"The telescope shown in the illustration has a clear aperture of 12 inches and a focal length of about eight feet. The mounting is of the English fork type, which is inherently balanced without counterweights. A tapered cylindrical aluminum casting, threaded inside throughout its length to break up light reflection, forms the main tube, and is forced into the short cast-iron barrel which acts as the lower end of the tube. This barrel is also threaded inside, so that no part of the interior presents a reflecting surface.

"The cast-iron fork has a tight, forced fit on the end of the polar axis. The latter is made of chrome vanadium steel,

Made in South Africa

heat treated and ground to exact size.

"The principal mirror is about 12¼ inches outside diameter, and is about two inches thick. It weighs 20 pounds and is mounted in a revolvable cell, with three sets of push-and-pull screws for adjustment. The revolving feature was devised so that true axial alinement of the mirror could be determined readily.

"The sky end of the tube has a cast-aluminum revolving head, carrying eyepiece and finder to insure a comfortable position for the observer, regardless of the altitude of the object being observed. The finder has a two-inch aperture.

"Five eyepieces are provided, and these can be used interchangeably in the finder or main telescope. In the latter they give magnifications varying from 64 diameters to 500.

"The mounting has closely divided circles, and is provided with clamps and slow motions for both declination and right ascension motions. The principal right ascension dial is rotated continuously during observation by means of a synchronous induction motor, which drives it through three sets of worm reduction units, having a combined ratio of more than 2,500,000 to 1.

"In using a synchronous motor drive for a telescope, it is necessary to interpose a pair of meshed gears having respectively 365 and 366 teeth, in order to change mean solar time into sidereal time. These have helical teeth to reduce vibration.

"The frame which carries the main tube is provided with two precision spirit levels for zenith setting. The declination axis and the polar axis run in eight ball bearings, which are protected from dust by felt washers within brass guards. All gearing is totally enclosed and runs in grease.

"The approximate weights of the principal parts are: base 1060 pounds; fork 410 pounds; polar axis shaft 104 pounds; assembled tube in ring with trunnions, mirror, cell, finder, and so on, 492 pounds; the total weight being over a ton.

"The telescope is housed in a sliding roof observatory, 15 feet by 18 feet, and the roof, which weighs about 2600 pounds, is moved on and off the building by a small electric motor, operating through sprockets, racks, and pinions.

"The telescope was designed, constructed and built in about two years. The mirrors were furnished by Mr. Wilbur Perry, of Springfield, Vermont. Inspiration for the work was furnished to a great extent by your book 'Amateur Telescope Making.'"

Amateur telescope makers may be surprised to learn that the first man to see the image of the new trans-Neptunian body on the photographic plate at Lowell Observatory was one of their number, Mr. Clyde W. Tombaugh. When the find was announced all the newspapers told how Tombaugh had made a telescope. Suspecting he might have used "Amateur Telescope Making" as his guide we looked in our file of purchasers, which is arranged by states, and found that he purchased the book in 1926. A wire brought from him the reply, "I used 'Amateur Telescope Making' in the construction of my telescope." Apparently, however, when he made his telescopes he never sent in a picture of the instruments for publication.

In a letter he now tells us that he has been swamped with correspondence since the discovery was made but appreciates

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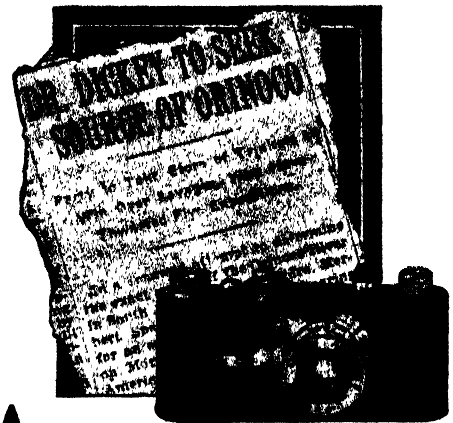

ANOTHER FAMOUS EXPLORER CHOOSES THE LEICA CAMERA

Because of its compactness and unfailing service on an instant's notice, Leica, the universal camera, was the choice of Dr Dickey when he and his party of five started into South America to find the unexplored watershed of the Orinoco River.

Invariably this remarkable camera is the companion of explorers, scientists, professional photographers and amateurs who recognize superlative camera quality. Several Leicas are owned by members of the Byrd Antarctic Expedition. Others were taken on the Graf Zeppelin's World cruise, the Greenland Expedition, through the Carlsbad Caves, and on the transcontinental Glider Flight of Capt. Hawks, sponsored by the Texas Company.

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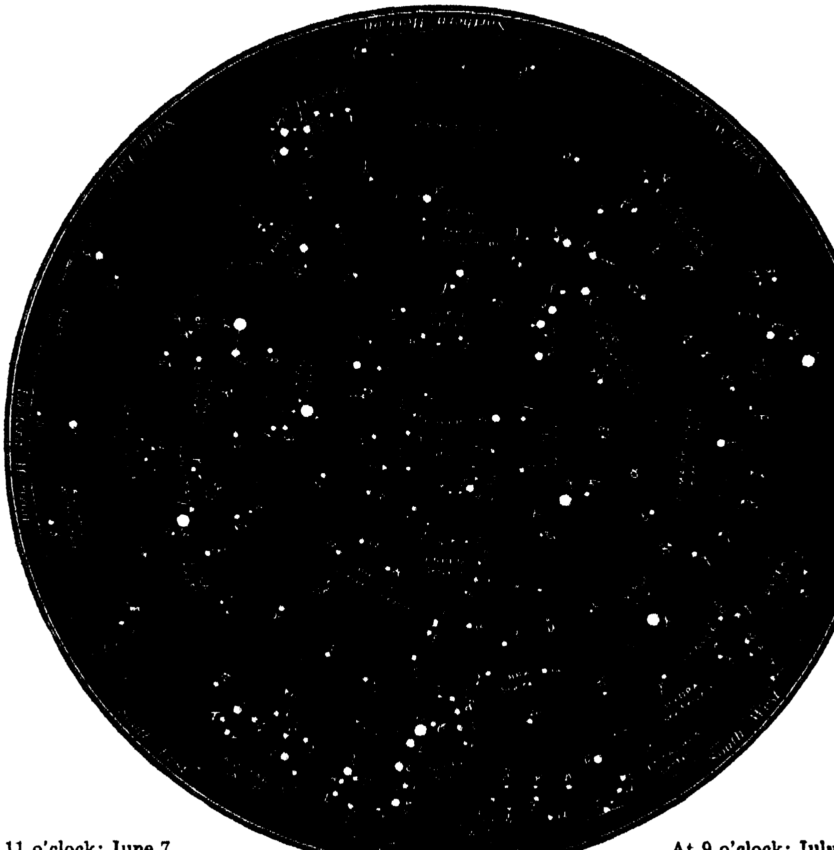
our interest, as a brother in the mirror art. At spare moments he says he is working on an article describing his construction of three telescopes, an eight-inch, a seven-inch and a nine-inch. In a later communication he apologizes for failing to keep his promise, as he has been side tracked with extra work, but ultimately will do so.

We hope this matter will reach us in time for the next number. It appears that the construction of his telescopes led Tombaugh to throw in his lot for astronomy. He asked for a place as assistant at Lowell Observatory and was accepted. Quite romantic, as it turned out.—*A. G. I., Tel. Ed.*

The Heavens in June

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: June 7.
At 10½ o'clock: June 14.
At 10 o'clock: June 22.
At 9½ o'clock: June 30.
At 9 o'clock: July 7.
At 8½ o'clock: July 14.
At 8 o'clock: July 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on June 7, etc.

NIGHT SKY: JUNE AND JULY

MERCURY is a morning star and is best seen about the 15th when he rises about 3.30 A.M. Venus is an evening star setting about 9:30 P.M., and is extremely bright. Telescopically she looks like the moon about half way between the quarter and the full. Mars rises a little after 2 A.M. in the middle of the month and still counts as a morning star. Jupiter is in conjunction with the sun on the 20th and is therefore unobservable. Saturn is approaching opposition and is observable in the latter part of the evening, though his low altitude is unfavorable to good telescopic definition. Uranus is a morning star and rises about 1 A.M. on the 15th; while Neptune sets at 11 P.M.

The moon is in her first quarter at 5 P.M. on the 3rd, full at 1 A.M. on the 11th, in her last quarter at 4 A.M. on the 19th, and new at 9 A.M. on the 26th. She is nearest the earth on the 27th and farthest away on the 16th. During the month she passes near Neptune on the 2nd, Saturn on the 12th, Uranus on the 20th, Mars on the 22nd, Mercury on the 24th, Jupiter on the 26th, Venus on the 28th, and Neptune for the second time on the 30th.

UNLESS protests are received from a sufficient number of its regular users the present feature, The Heavens (but not of course Dr. Russell's main articles), will be dropped and the space otherwise employed. Some believe there is but small overlap between the increasing numbers who are keeping up with the newer astronomy, mainly astrophysics, which is ably covered in Dr. Russell's monthly articles, and those who use the star maps and planet data. If the proposed change is made, a series of maps from the same plates will be especially printed in a small pamphlet for distribution to regular readers on request, and the same planet data as well as much other data not contained in the space allotted to the present department, could be obtained by the reader from the annual "Observer's Handbook" of the Royal Astronomical Society of Canada, at an outlay of only 25 cents, or from some other similarly accessible source.—*The Editor.*

Chemistry in Industry

(Continued from page 474)

the production of distillers' grains would amount to from 225,000 to 250,000 tons.

Beware of Noisy Grapefruit

READERS may recall the old story about the Italian fruit vendor who, annoyed by the critical examination of his wares by canny housewives, exclaimed, "If you mus' pincha da fruit, pincha da coconut!" After all, "pinching" does not prove much about the quality of the fruit and it is not surprising that a more scientific method has been sought. Now, the Bell Telephone Laboratories have developed a method of determining whether or not a grape-fruit is "good" without cutting it open.

This rather spectacular application of science is a method of detecting the Mediterranean fruit fly when it is inside citrus fruits. So far, says *Food Industries*, no way has existed for the detection of the larvae of the fruit fly inside the fruit without cutting it open—an operation which, of course, renders the fruit unsalable. The skins may appear to be healthy and yet cover a fruit that is infested with larvae that should be destroyed.

Since the worm eats by tearing off morsels of fruit, it has been argued by government entomologists that a noise should be caused by the operation, and if this sound could be sufficiently amplified by means of the thermionic valves, or tubes, used in radio, the noise of the larvae eating in the fruit should be audible to human ears. Apparatus in the nature of a glorified stethoscope has been constructed to test out the theory, and it has been found that "suspected" grape-fruit were noisy, and on cutting them open they were found to contain the offending pests, whereas noiseless grape-fruit were found to be free from larvae.

Human Chemist Can't Compete With Art of Lowly Bug

THE tremendous popularity of rayon as a substitute for natural silk must have created an unemployment problem among the silk worms. While the chemist with his wood pulp has outdone the worm with his diet of mulberry leaves, there is another insect, even humbler, which still retains his supremacy as a chemical factory. His name is *Carteria lacca* and his product is a resinous material which he produces to enshroud himself, but which man converts into the substance known as shellac.

W. H. Zinsser, writing in *Chemical Markets* reveals some of the many industrial applications dependent upon this louse-like inhabitant of India and Siam. Shellac is an organic resin produced through chemical processes taking place in the life of an insect and which, because of resiliency and soluble qualities stands out in world commerce in contrast to the vegetable resins. It has qualities possessed by no other gum and is soluble in alcohol or in an alkali water solution, but is not soluble in turpentine.

As long ago as 1590 there is a record of shellac having been dissolved and used as a coating or crude varnish, and from that date, uses, to which it is now so universally put, have been developed until to-day it

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is the "open sesame" to all phases of the painting and decorating art; the friend of the sculptor, electrician, and metal worker, and the companion of the woodworker and furniture finisher. It is the facile aide of the foundry pattern makers, the base of buttons, phonograph and talking machine records, telephone parts such as receivers and mouthpieces, and imitation ivory products such as billiard balls and poker chips. It is shellac that holds the filament of the electric light bulb in place, and it is the "size" or stiffening used by the hat maker, which makes possible the many shapes and styles that fashion demands. Shellac is one of the chief ingredients in sealing wax, light drying inks, shoe dressing, and wood cements; it is the "snap" in playing cards and the artful finish for leather, imitation leather, wall paper, hardwood floors, pencils, broom and brush handles, autos, pianos, and what not. Shellac is the modern finish of the up-to-date rubber rain coat; it is the sealer used to make "leak-proof" the myriads of gasoline tanks that line the highways; and is even used as a cement for sealing the seams in the manufacture of cans for foodstuffs and liquids. It is used in the manufacture of brushes as a cement to hold bristles firmly in place. It is an important ingredient in lacquers, giving them body, adhesion, and flexibility.

Chemists have spent years looking for a substitute for shellac for use in industry but have thus far been unable to better the job done by the diminutive *Carteria lacca*.

Black Light Betrays the Bootlegger

"BLACK" light, the invisible rays which are the longer wavelength part of ultra-violet, may be used to discover the source of industrial alcohol diverted to the bootleg trade, according to Dr. Herman Goodman in a recent paper presented before the Society of Medical Jurisprudence. By adding an invisible trace of certain fluorescent dye to their industrial alcohol, the manufacturers can always identify their own product, no matter how much it has been distilled or rectified, by turning on it the invisible rays of black light.

Moisture Affects Telephone Cords

TELEPHONE cords are insulated with silk and cotton threads, but chemists in the Bell Laboratories found that the insulating quality of the fibers is different according to dampness of weather.

Research located the cause, says *Chemistry and You*, house organ of the Arthur R. Maas Chemical Laboratories. These fibers contain fine traces of chemical salts, which attract and hold moisture, and lower telephone efficiency. So methods have been worked out for washing the salts from the fibers before they are braided onto telephone wires.

The water cannot be used twice, for the infinitesimal trace of chemical salts carried away, causes it to be regarded as "contaminated."

Lake Michigan water was found better for the purpose than water from the city supply at another plant. It was even better than distilled water. This was due to a slight proportion of helpful chemical in Lake Michigan water, and too much harmful chemical in the other water, but the latter has been made satisfactory by delicate chemical treatment.

Our Point of View

Questionable Success in London

(Continued from page 429)

The three powers will scrap tonnage as follows:

	United States	Great Britain	Japan
Capital Ships	70,000	134,000	29,000
Destroyers	76,000	35,000	17,000
Submarines	8,000	none	14,000
	154,000	169,000	60,000

This tonnage does not include any obsolete vessels; the capital ships do not go back of our modernized *Florida* class, and only reckons destroyers less than 16 years old and submarines less than 13 years old. So, on the credit side of the Conference is a substantial reduction in tonnage. Great Britain and Japan, having already built practically up to the limit of their cruiser allowance, will have a very small cruiser program to complete. Congress has already authorized a cruiser program that will eventually complete our cruiser quota under the treaty; it will require several years to finish. In the meanwhile we are well below our strength. The President should vigorously resume the program suspended while the Conference was in being. By a happy coincidence this program will help the unemployment situation.

To obtain an agreement our delegation was forced to concede Japan parity in submarines and an increase in the 5 to 3 ratio in six-inch cruisers. We thought we had conceded Japan enough in 1922, when we agreed to cease fortifying our Far Eastern bases; certainly this concession should terminate our constant yielding to our neighbor across the Pacific.

It is reported that there is a clause in our agreement with Great Britain that might permit her to increase her cruiser strength relative to ours in the event that France increases her program; there should be no uncertainties in this treaty. In 1922 we thought parity meant parity in all classes; we so interpreted it while Great Britain and Japan built cruisers, destroyers, and submarines until they upset the ratio entirely. It would be a blow to the future confidence of our people in the efficacy of international agreements if any fine-spun interpretations are placed on this agreement.

In spite of the reductions actually obtained, Americans generally are disappointed by the events of the London Conference; and they will not quickly forget the display of European jealousies so openly disclosed by the negotiations. Americans had been told that the failure at Geneva in 1927 was due to the unyielding attitude of naval officers who sacrificed accord rather than to yield a few cruisers; at least that theory is exploded for only the Japanese delegation contained a naval officer and he was carefully classified as a statesman. Yet these selected delegations of civilian statesmen have been entirely unable to bring about a five-power pact, and only succeeded by extreme concessions to Japan in effecting an agreement for a three-power pact. Their failure is more significant because

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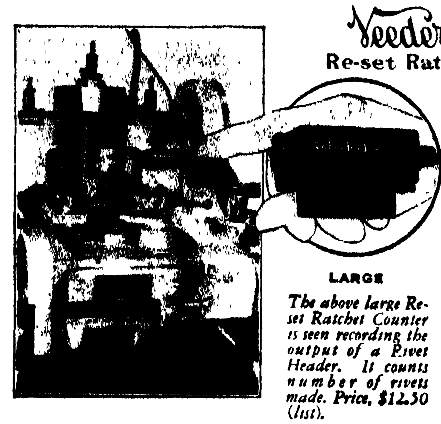
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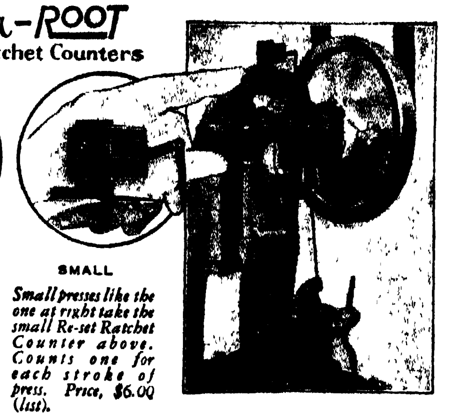
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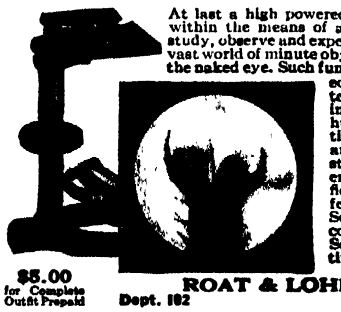

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they patiently explored every avenue of approach that held any promise of agreement; and it is also possible that the delegations at London, in their desire to reach an accord, may have gone beyond the wishes of their own countrymen. After carefully following the developments at the Conference, it is hard to escape the conviction that the world powers today are not ready to confide their future to treaties, but still prefer to trust in the efficiency of their own armed forces. This is the most significant fact that has come out of the Conference.

Italy and France have not conceded an item one to the other. The reason for this inflexibility is scarcely concealed. France heads one continental group that includes Jugoslavia, Czechoslovakia, Rumania, and Poland. Italy heads another group that embraces Hungary, Albania, Bulgaria, and hopes to include Turkey. Italy would like to have England dissolve the entente with France and join her group. But for the present at least, British opinion will not hear of any continental entanglements. The old European balance of power has reasserted itself but this of itself need cause us no alarm, for it is the classical European method of preventing a continental colossus; and whatever may be urged against it by world reformers, the balance of power did preserve the peace of Europe between 1871 and 1913.

The desire to create an agreement between France and Italy caused MacDonald and Stimson to suggest a "consultative" pact to be given to France in lieu of the security guarantee she demanded for a reduction of her naval program. It is reported that MacDonald could not carry his own cabinet with him on this proposal and both Baldwin and Lloyd George are known to be against any further guarantees to France.

The reaction in this country was overwhelmingly against any form of consultative pact, on the very sound ground that if it committed the United States to intervention in European affairs it was against all our traditions and if it did not, it would mislead France. All efforts by advocates of the consultative pact to explain that the United States was already committed to an intervention by the Kellogg-Briand renunciation of war and the four-power Pacific treaty failed. And our delegation was unable to explain its complete change of attitude in this matter. Perhaps Mr. Stimson allowed his eagerness for an agreement to blind his judgment temporarily, or he wished to canvass the American public to determine if, for the sake of a reduction in armament, they were willing to re-enter Europe's political orbit. If the latter, the negative answer was plain, and cannot be misunderstood. It further developed that Great Britain is scarcely less reluctant than the United States to guarantee France's position in the Mediterranean so it was not possible to reach a real five-power agreement.

In the early days of the Conference there was some evidence of a desire on the part of the British and American delegations to put pressure on France to make concessions by a threat of a four-power agreement that would leave France isolated. When France failed to respond, the same treatment was applied to Italy without success. Then it was realized that if a five-power treaty was impossible, it was better for the good-will of Europe to go at once to a three-

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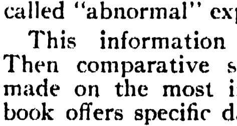

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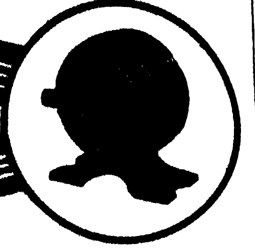

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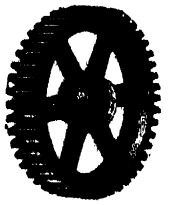

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power treaty, leaving in the framework places for both France and Italy, rather than to create a four-power treaty that would isolate one of them.

Just when the vexed situation seemed at its worst, Italy raised the specter of the League of Nations, by the very pertinent, if unpleasant, suggestion that the London Conference was not a competent tribunal to determine the nature of the security guarantees made by League members and suggested that the French delegation address such queries to the League Secretariat at Geneva rather than to MacDonald and Stimson. This action convinced Mr. MacDonald that Italy was immovable and efforts to secure a five-power pact were abandoned.

The original position of the United States was that if a five-power agreement could not be obtained, a three-power agreement would not be attempted, for it was feared that an agreement between the three largest naval powers would almost surely cause the rest of the world to believe that Great Britain, Japan, and the United States are seeking to dominate the world by their navies. When we recall the persistent French suspicion of a British-American entente after the Rapidan conference, the dangers of a three-power agreement are plainly evident. Nothing we would save in dollars by a reduction in naval expenditures would compensate for wholesale suspicion aroused throughout the world by the belief, however unfounded, of an understanding between the three naval powers. Our delegation must believe they can reassure the rest of the world on this point, else they would have adhered to their original position.

The result of the Conference may be summarized as follows: Great Britain concedes us cruiser parity provided we take part of it in six-inch cruisers and France and Italy restrict their programs. Japan agrees, provided she is allowed equality in submarines and a 10 to 7 ratio in cruisers for the present and the right to re-open the question when and if we build up to a 10 to 6.4 ratio; France and Italy will not join the pact. In 1922 we scrapped battleships and battle cruisers to arrange a 5 : 5 : 3 : 1.75; 1.75 ratio among these five powers. As an additional incentive to Japan, we ceased all work on our bases in the Far East so that the continued passage of time puts them more and more at the mercy of a hostile fleet operating in those waters. In addition to her fleet, Japan possesses the second strongest army in the world; it is futile for her to urge that additional naval strength is needed for defense of her already impregnable position in the Far East.

Yet for the sake of a three-power agreement that only a short time ago we said we would not accept, our delegation has accepted a conditional equality with Great Britain, and has granted Japan an equality in submarines and a 10 to 7 to a 10 to 6 ratio in cruisers.

Surely our delegation has gone to the extreme limit in order to obtain an accord. The Senate leaders will consider the pact in detail, and it is most fortunate for our country that it cannot be committed to any foreign obligations without full discussion in the Senate. The delay entailed by discussion sometimes frets us, but such discussion informs the American people and enables American public opinion to make itself felt.

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THE report of the National Research Council Committee, all of the members of which have planned and built chemical laboratories within the last ten years, definitely answers the leading questions as to the requisites for a practical laboratory building. Plans are prepared in detail for new buildings, or the improvement of existing ones, the data for which was obtained by sending out questionnaires to the directors of recently constructed laboratories. It is thus a compendium of present practice and as such is invaluable to this rapidly growing field of science. $1.20 postpaid.

BOOKS are one of the most intimate influences in our lives. They both entertain and sustain, they can be our companions in solitude and a stimulation in depression, they often are exhilarating and sometimes risible—of these our own mood is most frequently the gage. It is not an easy matter, therefore, to select from the large number that are now published, those titles which will interest a most cosmopolitan audience.

On these pages will appear each month the selections which The Editors believe likely to interest the greatest number of readers, but if you do not find here just what you like, or if you want to know what is available in some line of your own desire, do not hesitate to write to Louis S. Treadwell, Associate Editor, who is responsible for this department. Every attention will be given to your needs. We want to make these columns of real value to you.

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ONE is rather confused at the number of titles which have appeared concerning this dynamic and forceful patriot. This one is by his secretary and later intimate personal friend in whose hands were placed the full documentary records and these were supplemented by intimate conversations day after day; for Clemenceau was fully aware Martet was to be his biographer. In fact one long chapter is in Clemenceau's own hand. All facets of this amazing personality are turned to the light. In many ways, therefore, this is the most important portrayal of all the books that have appeared. $5.25 postpaid.

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Rules on Patent Appeals Amended

THE Commissioner of Patents, Thomas E. Robertson, has announced an order amending the rules of the Patent Office relating to appeals from its decisions and the printing of the record for use on appeal. The order follows:

Acting under the provisions of section 483 of the Revised Statutes and with the approval of the Secretary of Commerce, rules 148, 149, 150 and 162 are amended as follows, to take effect March 1, 1930:

Rules 148, 149, and 150 by striking out the words, "Court of Appeals of the District of Columbia" wherever they appear and inserting in lieu thereof: "Court of Customs and Patent Appeals."

Rule 162, by striking out in the fourth line thereof the words "Court of Appeals of the District of Columbia" and inserting in lieu thereof: "Court of Customs and Patent Appeals."

And by canceling the last sentence of the first paragraph thereof and inserting in lieu thereof the following:

"The size of the record shall be $7^5/_8$ by $10^1/_4$ inches and the type matter shall be $4^1/_6$ by $7^1/_6$ inches. They shall be printed in 11-point type and adequately leaded; and the paper must be opaque and unglazed. The names of the witnesses must appear at the top of the pages over their testimony, and the record must contain indices with the names of all witnesses and reference to the pages where copies of papers and documents introduced as exhibits are shown."

Patents for Plants

THE inventor or discoverer of a new variety of fruit tree or plant would receive the same protection by a patent as the inventor of a machine, through an amendment to the patent statutes introduced by Senator Townsend of Delaware, himself an orchardist, who said that he wished to remove the present "discrimination" against agriculture.

The patent would be granted to the experimenter under almost identical conditions governing other inventions and the law would be operative throughout the Patent Office, costing the government nothing, Senator Townsend explained, inasmuch as the Patent Office is self-supporting.

His measure, which has been passed by the Senate and approved by the House Patents Committee, reads, in part:

"Any person who has invented or discovered . . . any new and distinct variety of asexually reproduced plant other than a tuber-propagated plant or a plant which reproduces itself without human aid, not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings, obtain a patent therefor."

In evidence of the value of his proposal, Senator Townsend, who owns 130,000 acres of orchards, pointed to the accomplishments of engineers during a century of patent protection.

Pointing out that "it is a notorious fact that the most successful plant breeders have lived and died in comparative poverty," Senator Townsend named as examples Ephraim Bull, Luther Burbank, Peter Gideon, C. G. Patten, J. R. Reasoner, and Dr. Van Fleet.

Californians Lead in Patent Grants

RESIDENTS of California are the nation's most prolific contributors to mechanics and the sciences, according to the records of the Commissioner of Patents. The record of patents granted during the year 1929 showed that citizens of Connecticut pressed closely on the heels of California's inventors, and three other New England states put in strong bids for the *per capita* honor. These were Massachusetts, New Hampshire, and Rhode Island.

As would be expected, the State of New York led by a wide margin in the total number of patents granted to its residents. The compilation, made by Mr. L. Edward Flaherty of Washington, D. C., shows the grants issued to the various states, the leaders ranking as follows:

New York	7755
Illinois	4658
Pennsylvania	3639
Ohio	3595
California	3087
New Jersey	2630
Massachusetts	2309
Michigan	2218
Wisconsin	1321
Connecticut	1121

A total of 42,251 patents were issued in 1929, compared to 40,322 issued during the preceding year.

Shoe Trademarks

THE Assistant Commissioner of Patents has denied a rehearing of the appeal before him in which he decided that the notation "Foot Preserver" is registrable as a trademark for boots and shoes, despite the opposition of the owner of the mark "Arch Preserver" for the same type of goods.

It was held that the essential feature of the mark "Arch Preserver" is not "Preserver," but that "Arch" is the dominant characteristic, and hence "Foot Preserver" is not deceptively similar.

By reason of many trademarks for shoes of like import, the Assistant Commissioner stated that neither party is entitled to such broad protection of its mark as to exclude from registration the mark of the other party, and that the public must exercise unusual care in discriminating between them.

Massachusetts Bans Car Radios

RADIOS may not be operated on automobiles driven in Massachusetts, according to a ruling by the registrar of motor vehicles, George A. Parker.

The ruling followed a conference with the governor's committee on street and highway safety, which recommended that the use of radios on automobiles be discontinued, it was announced.

Automobile and radio manufacturers have joined in a protest to the department, of which the registry of motor vehicles is a part, under a law providing that any ruling by the registrar is subject to appeal to the Department of Public Works.

"Permanize" Granted Trademark Registry

ALTHOUGH two trademarks may have the same suffix, and the goods upon which the marks are used are of the same descriptive properties, they are not deceptively similar if they neither look alike, sound alike, nor convey the same thought. This decision of the Assistant Commissioner of Patents was made in the case of the Simoniz Company *vs* Permanizing Stations of America, Inc., opposition number 9230 to registration of trademark "Permanize" for a polish for auto bodies, et cetera.

The opposer, the Simoniz Company, had appealed from the decision of the examiner of interferences dismissing its opposition to the registration of the mark. The opposition was based on the fact that the mark "Simoniz" for a compound for cleaning and polishing automobile bodies, et cetera, had been adopted and used previously. Although the two compounds contain specific differences, they were held to possess the same descriptive properties.

It was brought out that of the two marks in question, "Simoniz" is derived from the proper name Simon, and suggests the thought that Simon's reputation is back of the goods. On the other hand, "Permanize" is derived from the word permanent, and suggests permanency. The testimony failed to show that any purchaser had been deceived by the alleged similarity of the marks, and it was ruled that the marks are not deceptively similar.

Models for Advertising Purposes Denied Free Entry

ACCORDING to the majority opinion of the United States Court of Customs and Patent Appeals, models of "individual wheel drives" imported by the American Brown-Boveri Electric Company are not admissible duty free, as are models which come under Section 1620 of the existing tariff act. This action was taken because the models in question were imported for the purpose of free distribution with a view to prospective sales.

In the opinion of the Court: "It is apparent that the imported articles are made to be used not as models, but for advertising purposes alone."

The models in question consist of a solid brass foundation on which are mounted three supports, also of brass. From these supports are suspended an axle and two flanged car wheels. On the outside of one of these wheels is a brass cogged wheel with an attachment by which the axle and car wheels may move in various directions without affecting the cogged or drive wheel. Attached to the supports upon which the axle is mounted are two small levers with suitable arrangements whereby the operation of the mechanism can be demonstrated.

Because of the ambiguity of the language of the statute, it was deemed necessary to take recourse to its legislative history. Earlier tariff acts provided free entry for "models of inventions and of other improvements in the arts, including patterns for machinery, but no article shall be deemed a model or pattern which can be fitted for use otherwise."

The Court ruled that models intended for advertising use did not come under the statute. Judge Bland concurred with Judge Garrett in a dissenting opinion, holding that "advertising" use should be no bar to free entry, because it is inseparable from an inspection of the structure and is a legitimate part of the function of a model.

Old Mining Claim Upheld Over Invalid Homestead Patent

IF the owner of a mining claim fails to do his assessment work for one or more years, the claim is subject to relocation by other parties, providing the relocation takes place before the original owner returns and resumes work upon the claim. However, in the event that the relocation does not take place within that time, the owner's rights may be restored to the same extent as though there had been no failure to do the assessment work. These rulings were made by the Supreme Court of the state of South Dakota in the case of Frank Hebert *vs* Frank C. Bond *et al*, on appeal from the Circuit Court of Pennington County.

The defendants had acquired title to the Tin City Lode Mining Claim from a woman who had obtained a homestead patent on the property by means of false statements made to the General Land Office. The Court held that she had practiced a fraud both upon the Government and the rightful owner of the claim, so that her patent was impressed with a trust in favor of the original patentee who might go into court and have his title quieted.

The evidence showed that in 1886, Frank Hebert had discovered on unappropriated government mineral lands in South Dakota a lode of ore bearing appreciable quantities of tin and mica. He filed a claim promptly, and did all of the proper and requisite things to secure a valid title to the property covered in his claim. Later in the same year, one Mary McDermott built a cabin on an adjacent piece of farming land. After the year 1900, she filed a homestead claim in the land office, later revising her claim from time to time. In 1916 she amended her homestead claim to include the Tin City lode. As late as 1918, the testimony showed, McDermott admitted to witnesses that the mining property was owned by Hebert.

Early in 1919, Hebert contracted to sell the Tin City Mining Claim to one W. N. Hunter, for a consideration of 30,000 dollars. Hunter, with Frank C. Bond, formed the Rare Minerals Company, and entered promptly upon the property, making preparations to mine and ship ore from the mine thereon. At this time, while Hebert was away temporarily, McDermott drove the defendants (Rare Minerals Company) from the property, claiming title under a homestead patent issued by the government. The Rare Minerals Company decided that McDermott had a better title than Hebert, and purchased the McDermott homestead for the amount of 10,000 dollars. Then, attempting to repudiate the old Hebert title, the defendants filed a new mining claim on the Tin City lode.

The only questions involved in the case were: First, did the plaintiff ever make a valid location of the said ground? Second, is the ground covered by the Tin City Lode Mining Claim mineral in character? And third, if such location was made, did the plaintiff lose his rights therein by abandonment prior to the issuance of the McDermott patent? These points were decided definitely in favor of Hebert, and it was established that McDermott had practiced a fraud on both the plaintiff and the government. Under such circumstances, it was held, a court of equity has power to secure the rights of the plaintiff, and as a means best adapted to that end may declare a constructive trust in his favor. The decision of the lower court was affirmed, quieting title in the plaintiff.

"7-11" As a Trademark

THE Court of Customs and Patent Appeals has affirmed the Patent Office in dismissing opposition to the application for registration of the trademark "7-11," for liquid medicinal preparations. The products of the applicant, liquid medicinal preparations for treatment of colds, et cetera, to be taken internally, and of the opposer, owner of the mark "4711," for antiseptic mouth washes and scalp remedies, cold cream, face powder, dental preparations, et cetera, were held not to be of the same descriptive properties. It was also pointed out that the labels were dissimilar and further that the opposer had made no protest to other registrations of the numbers "7-11" for other goods.

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion, minimum number of words per insertion 24, maximum 60. Payment must accompany each insertion.

Anyone desiring the address of a patentee listed in this section may obtain it by addressing Munn & Co., those desiring official copies of patents herein listed, may secure them by remitting 15 cents for each one (state patent number to insure receipt of desired copy) to Munn & Co., 24 West 40th Street, New York City.

Pertaining to Aeronautics

Propelling Device—For air and water craft, whereby increased force is obtained, a quicker take-off will be possible and shorter landings at steeper angles, a gyroscopic action being generated to keep the craft steady while in flight. Patent 1750382. Westinus Boer.

Aircraft—Having a fuselage, laterally extending wings, stabilizers, and a rudder mounted at the tail, the special feature being a sail adapted to use the wind for producing the lifting action and motion to put the craft in flight. Patent 1752241. John Domenjoz.

Pertaining to Apparel

Necktie-Lining Fabric—Composed of a woven integral piece of material, adapted to be cut to serve as tie linings, having areas at one or both ends, which are of different grade of material than the remaining area. Patent 1749634. Edgar K. Frank.

Protective Garment—Designed to be worn by a messenger carrying money or valuables, so that the articles may be distributed throughout the compartments on the inner face of the garment, and securely locked on the user's body. Patent 1749714. Herman A. North.

Shoe Construction—Which has novel means for removably securing a heel to the body portion of a shoe, a frame receiving the heel, whereby a worn heel may be removed for repair, or a new one disposed in place. Patent 1749864. Joseph Weiss.

Cravat Attachment—For the small end of four-in-hand cravats, may be easily applied to provide an abutment to prevent its withdrawal through the knot, whereby the neck loop is at all times maintained without retying the cravat. Patent 1750232. Segfrid J. Lindskog.

Chemical Processes

Photographic Chemical Process and Material—For printing from tracings, etc., comprising diazotizing an aqueous solution of pyridine sulphonic acid, then reacting the product with an aqueous tartaric acid solution and an aqueous solution of a nickelous sulphate, coating photographic paper therewith, printing by contact under tracings, and developing the latent image with fumes of ammonia. Patent 1752174. Oliver A. Hall.

Designs

Design for a Table-Receptacle Holder. Patent 80626. Samuel Lapin.

Design for a Novelty Spur. Patent 80563. Grover C. Welter.

Design for a Dress.—The inventor has been granted two ornamental designs for dresses. Patents 80658 and 80659. Dorothy Long.

Design for a Dress. The inventor has been granted four patents on ornamental designs for dresses. Patents 80795, 80796, 80797, and 80798. Dorothy Long.

Electrical Devices

Modulator for Radiotelephones—For use in connection with the transmitter, use being made of carborundum, selenium, magnetite, etc., to vary in electrical conductivity, hinder action of heat or light, in producing a changing current in the talking circuit. Patent 1750579. Henry H. C. Dunwoody.

Electric Insulator—A tubular casing especially adapted for outdoor aerials in protecting them from moisture, the formation of ice, snow and water, which might tend to bridge the gap and electrically connect the wires. Patent 1750352. John F. Phillips.

Electric Storage Heater—A hollow body of heat absorbing and retaining material in which a large amount of electrically produced heat may be stored under control for use at such time as desired for various purposes. Patent 1749115. Gunnar S. Tune.

Electric Switch—The construction of which makes it impossible for an operator to leave the blades close enough to the contact to allow any passage of current, unless manually pressed into contact for closing the circuit. Patent 1752236. Vernon A. Conklin.

Of Interest to Farmers

Egg-Protecting Means—An outer protective covering adapted to be used with egg crates, as generally formed, and packed, for the complete closure and special protection of eggs in transit, when the temperature is below 32°F. Patent 1749675. Paul A. A. Rouis.

Door for Silos—Which may be readily removed to provide an opening for the discharge of grain, the door securing means also providing rungs, whereby an operator may climb to the upper portion of the silo. Patent 1750600. Levi D. Houghtaling.

Potato Separator—For use in connection with a potato digger, the tension of the balanced separating fingers permitting the lightest stone to drop from the potatoes as the digging, sorting, cleaning, and sacking operation progresses. Patent 1751391. William G. Bunker.

Doffing Device—For stripping or doffing the needles of a cotton-picking machine after the former has removed the cotton from plants, and for removing any accumulation of gum collected during abrasions of the plant stalks. Patent 1751389. Oscar F. Bledsoe.

Shipping Box for Baby Chicks—Each compartment of which has ventilated chambers of varying temperature so that the chicks may move at will to warmer or cooler places to meet their individual needs, and yet remain fully protected against drafts. Patent 1752177. Albert B. Hilkemeyer.

Of General Interest

Ventilator—For use in conjunction with a window allowing air to enter a room, but dividing the air in such manner as to prevent drafts, and also to exclude rain and other elements of weather. Patent 1750413. Albert R. Laube Nstein.

Air-Cooling Apparatus—Comprising a water supply pipe, overlapping absorbent fabric strips mounted to retard the water in its descent, and a drip pan on the window sill, the device cools and filters the air as it passes. Patent 1750047. Gustave A. Metzger.

Bag Gusset—So formed as to join the opposite ends of the side sections that they will be neat in appearance, and define a pocket which will prevent small articles from falling out. Patent 1750375. Anthony M. Vinciguera.

Combined Article of Furniture—A cabinet which includes hingedly connected sections defining storage compartments, a horizontally disposed swingable table, and swingable mirrors, normally housed, the whole serving in the capacity of a dressing table, desk or storage cabinet. Patent 1749686. Theodore Agazzi.

Brush Holding and Cleaning Device—A receptacle for receiving a quantity of turpentine or other detergent for cleaning paint brushes, scraper elements being arranged for the removal of the paint and detergent, and valves for draining off the waste matter. Patent 1748789. Harry I. Orkin.

Hair-Waving Device—Wherein the cooperating hair-waving members may be closed in engagement with the hair fully and effectually, to produce the desired waves without injury or tearing the hair. Patent 1749748. Martha A. Tienken.

Cartridge Guide for Repeating Guns—So formed that its head portion which is provided with a guiding surface shall penetrate into the breech casing between the magazine and the rear end of the barrel, or the firing chamber. Patent 1749726. Rudolf von Frommer.

Fence Post—Polygonal in cross section, and formed with means for interlocking engagement by tie wires, in securing the line wires, a projecting member at the lower end being adapted for setting into a fresh concrete base. Patent 1749640. Richard D. Martin.

Container—A simple and convenient envelope or wrapper for easily and quickly confining articles of personal wear, such as shoes, etc., when traveling, within a relatively small space, and without soiling other articles in transit. Patent 1749680. Gertrude P. Visscher.

Mop Handle—Having a simple and efficient means whereby a mop head, or mopping material, may be inserted or removed and when connected will spread out over the end of the stick to prevent contact with floors or furniture. Patent 1752250. John H. Gillis.

Display Holder—Particularly adapted for strap-watches, and formed from a single cardboard blank and a single sheet of velvet, a pocket being formed for the watch, means for displaying the strap, and supporting the holder in tilted position. Patent 1752246. Leo Flier.

Sea Tub—A hollow construction, of rigid buoyant material, such as balsa wood, adapted for floating persons in the water, the size being large enough to permit the average person to lie down in the water, as in a bath. Patent 1752191. Jere C. Moray.

Jar-Cover Remover and Fastener—A device which may be attached to a wall or other suitable support, for receiving and gripping the metal cap of a jar, while the latter is being turned for screwing or unscrewing, without spilling the contents. Patent 1752189. Joseph Lotz.

Watch Stand—Comprising a substantially dome-shaped base and a plurality of arms, pivotally mounted, wherein a watch may be quickly mounted or demounted, particularly adapted for use in repairing watches. Patent 1751286. Frank X. Mantsion.

Mop—With mechanism so constructed as to eliminate all necessity for the hands of the user to come in contact with the water in mopping, scrubbing, or wringing, the operation being easily accomplished without undue exertion. Patent 1751349. Clifton O. Morgan.

Holder for Graphic-Instrument—A holder connected with a base, for temporarily holding a fountain pen, or the like, in angular position, so that the instrument may be easily removed or inserted, the holder accommodating instruments of various sizes. Patent 1751354. Ernest Oldenbusch

Washbasin Appliance—A transportable storage tank for water, the top portion being depressed to form a basin, a lift pump transfers the water to the basin, the device is covered, very compact, and adapted for use in confined places, such as vehicles. Patent 1751294. Clifford Spital.

Hardware and Tools

Screw—Having the usual slotted head for receiving the screw driver, but being provided with lips adjacent the slot so that after the screw has been forced into position, said lips, or wings, may be swaged over the slot. Patent 1749043. Joseph Neiser.

Flat Iron and Steamer—Particularly adapted for ironing or steaming a hat, and permitting the crown or brim of the hat, or both, being ironed or steamed in a convenient manner; may also be used for other purposes. Patent 1749667. David Freedlein.

Knife Attachment—An attachment for the back of a knife blade, affording a broad support for the fingers, and preventing soreness after long use, particularly adapted for paring knives, as used for vegetables and fruit. Patent 1750577 Joseph de Bracht.

Casement-Window Latch—Which provides means for securely latching a casement window in slightly opened position for the purpose of ventilation, but in such manner as to prevent an intruder forcing or manipulating the latch to gain access. Patent 1750423. Walter S. Oglesby.

Fire-Fighting Tool—Comprising a handle, a metallic extension, and a blade with lug-receiving opening and a clamping member for securing the blade against rotation, the wooden handle being removed at quite a distance to prevent charring. Patent 1749103. John C. Kortick.

Rotary Reamer—For reaming oil wells, the reamer blade having two cutting eges, thus twice the efficiency of ordinary reamers, the tool requiring withdrawal for sharpening with but half the frequency of a single blade, thus saving time and labor. Patent 1750953. Alexander Boynton.

Safety Shackle Snap—A snap hook which when engaged about a shackle will automatically close and lock in instances of strain, but may be easily unlocked and relocked by manual operation in the absence of strain. Patent 1751458. John J. Van Valkenburg.

Pipe-Bending Tool—Which may be employed to bend the usual standard, or thin wall conduit, in various sizes, will not cause the conduit to flatten, and will prevent slipping or incidental injury during the operation. Patent 1752220. Andrew B. Allen.

Machines and Mechanical Devices

Automatic Well-Flowing Device—A combination pressure fluid and liquid velocity control device embodying a flap movable toward one side by the velocity of the stream and returning to its original position as the stream force diminishes. Patent 1749124. Alexander Boynton.

Rod Guide—Comprising a walking beam, for maintaining a polish rod of an oil well pump jack in true alinement, while providing a maximum stroke and the greatest quantity of oil, with the least sucker rod trouble and wear. Patent 1749626. Charles H. Brown.

Stripping-Finger Adjustment for Thrashing Machines—Whereby the rows of stripping fingers of machines used for operating upon the pod or hull type of crops may be projected or withdrawn at will, according to the weather conditions at the time of working. Patent 1749040. Carl R. Livermon.

Conveyer—Of the endless belt type, applicable for quenching and removing furnace or gas producer ashes, or metal articles after heat treatment, or may be applied as a hydro-mechanical conveyer and separator. Patent 1750426. Harry E. Partridge.

Device for Separating Water from Oil—A valve and float automatically acting to separate water which has gravitated at the bottom of a settling tank for oil and water, the action being accomplished in a continuous and clean manner. The float may be readily adjusted or removed from the separator tank. The inventor has been granted two patents, 1750489 and 1750490. John W. Pippin.

Mouth Wiper—For linotype machines of the Mergenthaler type, the movement being actuated by the ejector mechanism and includes a flexible wiping piece resiliently held in taut position and readily removable from or replaced on the structure. Patent 1750402. Henry G Guire and Albin L. Chalfonte.

Piston - Ring - Fitting Machine — A machine by which the grinding of piston rings incidental to fitting them in engine cylinders can be accomplished with a mathematical exactness, the machine is adjustable for practically all forms and sizes of rings. Patent 1750195. Granison M. Sanders.

Pump Plunger—A built-up plunger wherein most of the plunger is made from vitreous or other acid-resisting material capable of resisting the action of chemicals in water to be pumped from mines. Patent 1751350. Fred W. Moyer and Frank J. Reninger.

Box Forming and Sealing Device—Adapted to receive a blank which has been indented for determining the side walls, bottom and top, fold the blank, and apply a sealing tape to the abutted edges after the box-like structure has been formed. Patent 1751390. Walter W. Vrust.

Cutting Device—An attachment in the form of a rotary cutter comprising a disc-like body which may be readily mounted in connection with a paper tube forming machine for automatically cutting the product into predetermined lengths. Patent 1751293. Harold W. Sherman.

Water-Locking Suction Valve for Hydrocarbon-Fuel-Storage Tanks — Whereby fine dirt, scale, etc., frequently present in gasoline, and which settles in the water strata at the bottom of the tank, cannot be drawn up to prevent a proper closing of the check valve. Patent 1751371. John H. Viele.

Revolving Lathe Center - For the tail spindle of a lathe, which revolves instead of being stationary, thereby eliminating burning in wood turning, and is lubricated in such manner as to require less energy in running the lathe. Patent 1751711. Harold R. Ong.

Coin - Controlled Liquid - Dispensing Apparatus—Which can be operated in conjunction with gasoline and lubricant pumps, and will expedite the sale, by eliminating employees and permitting autoists to purchase the product at such times as the station is ordinarily closed. Patent 1752150. Ernest E. Cooper.

Long-Stroke Pumping Jack—Adapted for use with oil wells, may be easily unlimbered for temporary displacement preparatory to pulling a sucker rod, whereby weight elements may be added or substracted on the reciprocating chains to suit different loads. Patent 1752144. Lawrence G. Burt.

Medical and Surgical Devices

Orthodontic Dumb-Bell—Formed of a temporarily deformable elastic material, comprising a cylindrical shank with an enlarged integral spherical knob at one end, for the treatment of irregular teeth and development of the human maxillary and mandibular bones. Patent 1749682. Harry C. Ferris.

Tonsillotome—Of the guillotine type, including a pair of blades one initially directing an electrical current to the base of the tonsil, causing coagulation and reducing bleeding to a minimum, the other severing the appendages. Patent 1750874. Arthur C. Campbell.

Dental Mirror—Having a lighting attachment arranged in such a way that the rays are reflected from the surface of the mirror and illuminate the mouth so as to facilitate the inspection of the teeth. Patent 1750194. Carl G. A. Rydman.

Musical Devices

Phonograph Stylus and Sound Box—Wherein a plurality of stylus points may be associated with the sound box for consecutive use in combination with the sound groove of a record, and any one of the style positioned for playing. Patent 1750351. Auguste E. Pasche.

Plumbing and Fittings

Compound Faucet—A double faucet attachment to a single pipe whereby water may be drawn from one faucet inside the house while the other faucet is being used for a hose attachment outside the house. Patent 1750485. Gustav Muller, Jr.

Prime Movers and Their Accessories

Auxiliary Air Supply and Mixing Device for Internal-Combustion Engines—Which thoroughly incorporates the air with the explosive charge from the carbureter and causes the mixture to be automatically delivered in correct combustible quality to the manifold at all speeds of the engine. Patent 1748203. Gaston A. Brunelle.

Rotary Internal-Combustion Engine—Wherein carbon deposits are materially reduced if not eliminated, and which will develop a maximum horse-power with a minimum gaseous fuel consumption, utilizing substantially all the power before the exhaust products escape. Patent 1750502. Thomas A. Baker.

Internal - Combustion Engine—Designed to perform perfectly the four cycles of the usual four-cycle engine, and employs a new principle of compression and expansion which has distinct advantages over the usual type, the engine being comparatively light in weight. Patent 1751385. George P. Beaudry.

Two-Cycle Engine—Having a time-controlled valve which will force gases of combustion into a cylinder at the proper time, under the proper pressure and permit these gases to exhaust at the proper time. Patent 1750201. Gardner A. B. Spencer and Harry B. Cornish.

Internal - Combustion Pump — Whereby charges of fuel are controlled in such a manner as to avoid pre-ignition, thereby enabling greater compression, and so to make it possible for the pump to operate against heads of liquid in excess of two hundred feet. Patent 1752130. Eric W. MacKay-White.

Railways and their Accessories

Ballast-Dressing Machine for Railroads—A preliminary ballast spreading and leveling apparatus whereby ballast dropped upon a railroad in piles may be smoothed out or spread in an even and expeditious manner before the finishing operation. Patent 1750506. Solon F. Clapp.

Pertaining to Recreation

Doll—Constructed with a hollow hard casing and flexible swinging legs, whereby the doll may simulate the movement of human beings in walking by a forward turning movement first one side and then the other. Patent 1750404. Louis Herman.

Toy Target—In which the target elements are swingably mounted and have an indicia carrying portion adapted to be swung into position to expose the numerical value associated with each target, when struck by a projectile. Patent 1749689. Fred T. Baum.

Pertaining to Vehicles

Brake Mechanism -Wherein the braking elements will be self-centering, so that the active brake lining will be uniformly applied to the braking surface of the drums, and the wear evenly distributed over the entire area. Patent 1749624. Jonas W. Batson.

Road - Map - Exhibiting Apparatus for Motor Vehicles- Which is operable by the forward movement of the vehicle to be successively exhibited in a manner to continuously indicate to the motorist his precise geographical location, may be readily applied to an automobile. Patent 1749243. William L. Eglinton.

Gear Shift—An automatic mechanism whereby the shifting of gears from operative into neutral, and into another operative position, during one continuous movement of the clutch, prevents the gears shifting from second or third speed into reverse. Patent 1749837. Arthur C. Nickell, Jr.

Tire-Deflation Switch—A signal or alarm, electrically connected with the usual ignition or lighting circuits, and giving warning to the operator of an automobile of the deflation of one or more of the tires during travel. Patent 1750563. Joseph Berger.

Steering Mechanism -For vehicles, whereby the operator will be relieved of much manual labor, the operation requiring practically no effort regardless of whether the vehicle is moving or at a standstill, so long as the vehicle's motor is operating. Patent 1749816. William R. Hendrix.

Vacuum - Cleaner — Whereby the suction created in the intake manifold can be utilized to perform the functions of a vacuum cleaner, the dust being prevented from passing into the manifold or interrupting the normal operations of the engine. Patent 1750800. Sydney R. Gould.

Internal Spring - Metal Reenforcing Member—Which will take the place of the ordinary inner tube, may be readily inserted within a vehicle tire, and conform to the inner walls, and will force the tire beads outwardly against the rim. Patent 1751741. Victor Karbowski.

Auxiliary Control for Motor Vehicles—Which permits the driver of a house-to-house or short-stop delivery zone truck, to automatically start or stop his car, either from the usual driver's seat, or from the delivery door, thus saving much time. Patent 1748041. Herman T. Backhus.

Automobile Identifier— A frangible support for a license plate or other identifying mark, so that in a collision the supporting means breaks and causes the indicia to drop, thus leaving identification in case the driver escapes. Patent 1747446. Stephen G. Krile.

Hydraulic Power Transmission—In which a fluid is employed for effecting a silent driving engagement and cushioning effect of one shaft with another, thereby eliminating jolts and harsh mechanical connection, as in ordinary motor vehicle transmissions. Patent 1748436. Victor Arkin.

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Lack of space makes it impossible to give many cross-references or to enter a given reference in more than one place. Each article is therefore entered where it is believed it will be most easily found. In every case, the general subject should be sought rather than the supposed specific title of an article. We call special attention to the classifications "Aviation," "Engineering," "Medicine," "Miscellaneous," etc., under which many items will be found, the location of which otherwise would be very puzzling.

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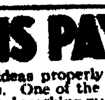

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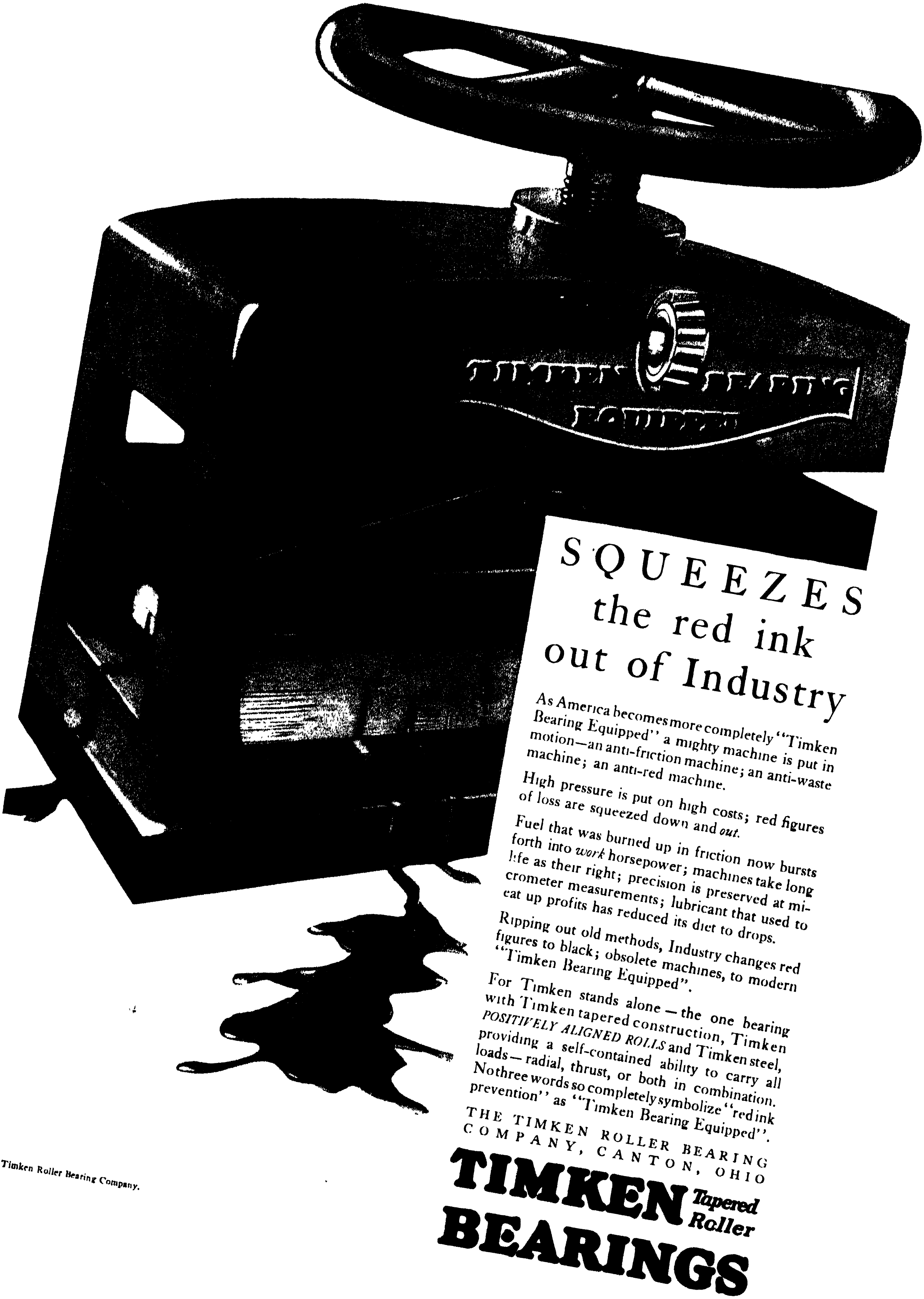

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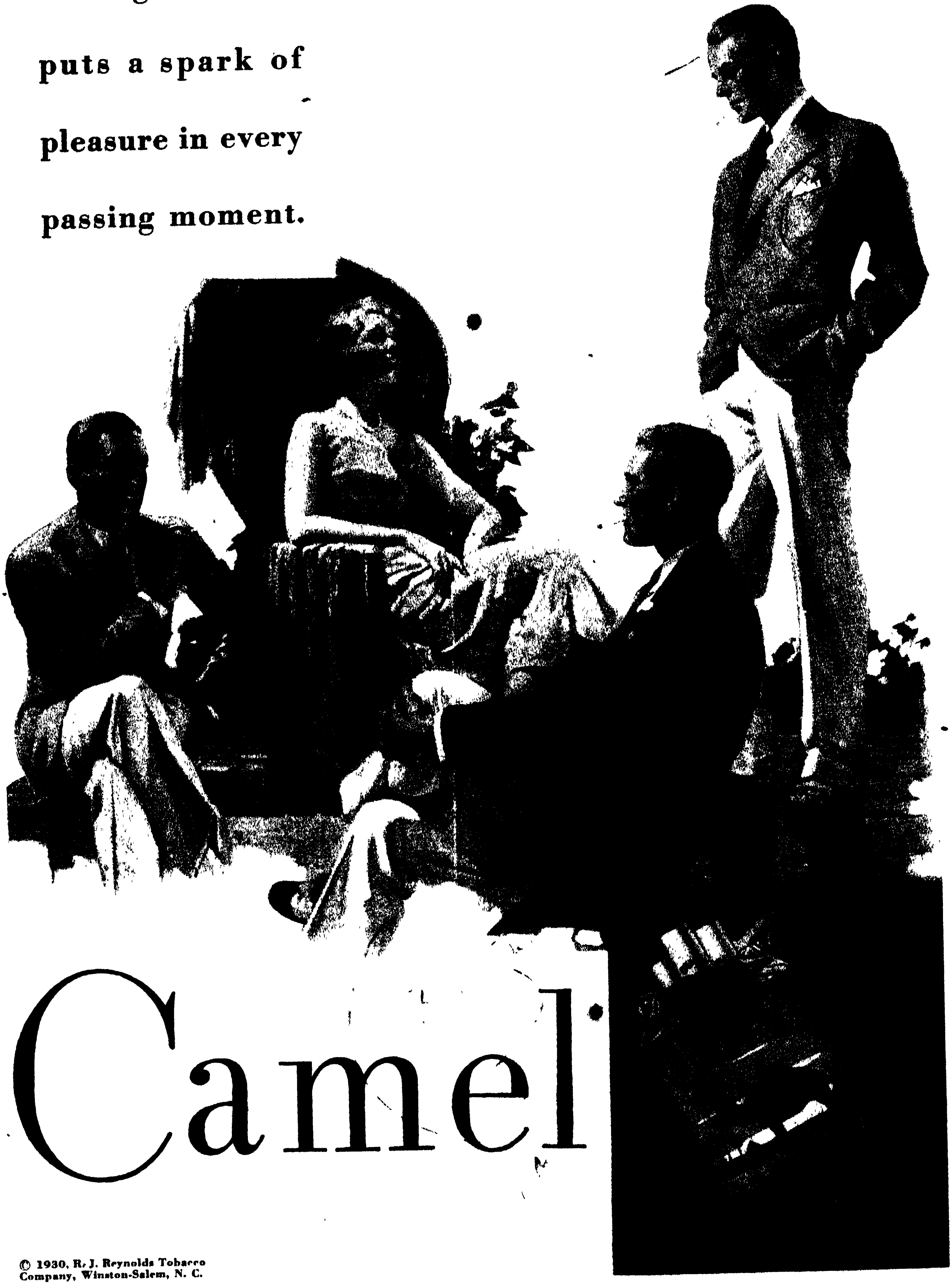

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